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ABSTRACT

This report is the sixteenth in the series of Reviews of National Science Policy by the Organisation for Economic Co-operation and Development. It has two purposes: first, to enable the countries concerned to appraise the political, economic, and structural aspects of the action taken to reinforce the role of scientific and technical research in the achievement of national goals; and second, to enrich the pool of available knowledge on the content of science policies and their role as an instrument of government. In the first part of this document a background report is provided, with information organized under the headings: The Scale and Dynamics of R & D Activity, Institutions of Science Policy, Prosperity Through Research, Research in the Service of the Community, University in Search of New Ends, and Science Policy and National Goals. In the second part, research and development activity is analyzed in the three main branches--industry, government, and universities--and points are raised which should be considered for its future development. (DT)

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REVIEWS OF NATIONAL SCIENCE POLICY

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ORGANISATION FOR ECONOMIC
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REVIEWS OF NATIONAL SCIENCE POLICY

NETHERLANDS

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FOREWORD

The present report is the sixteenth in the series of Reviews of National Science Policy. *

These reviews have two purposes: first, to enable the countries concerned to appraise the political, economic and structural aspects of the action taken to reinforce the role of scientific and technical research in the achievement of national goals. From this angle, the review gives the country concerned an opportunity to take stock of its own science policy.

Secondly, the reviews help to enrich the pool of available knowledge on the content of science policies and their role as an instrument of government. In this way, OECD Member and non-member countries can derive lessons which will help them to perfect their own scientific and technical set-up and improve their methods. Similarly, through this improved knowledge of the resources deployed by Member countries, the reviews help to strengthen international co-operation in science and technology.

Although each review is mainly centred on the specific problem of the country under review, there is a common procedure for preparing and conducting them. The process of review consists of the following stages:

- The preparation by the OECD Secretariat, with assistance of the country under review, of a Background Report;
- An information mission: a team of Examiners visits the country under review and contacts those responsible for science

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* The following countries have already been reviewed (in chronological order of publication): Sweden, Greece, Belgium, France, the United Kingdom and Germany (together), Japan, the United States, Italy, Canada, Norway, Austria, Spain, Switzerland, Iceland,

policy, senior officials, industrialists and academics. The Examiners also visit a certain number of laboratories, universities and public institutions. The aim of this second stage is to supplement the information provided by the Background Report and to enable the Examiners to formulate, as a first approximation, what they deem to be the main problems raised by the implementation of the science policy under review: this constitutes the Examiners' Report;

- The presentation, after appropriate revision, of the two reports to the OECD Science Policy Committee, which then holds a Confrontation Meeting at which representatives of the country under review answer questions put by the Examiners and the Delegates of Member countries;
- The publication of all documents relating to the review: the Background Report, the Examiners' Reports and the Account of the Confrontation Meeting.

For the review of science policy in the Netherlands, the documents are published in two parts:

- Book I: Background Report;
- Book II: Examiners' Reports and Discussions.

The members of the Team of Examiners were:

- Dr. Ivan L. Bennett, Director of the Medical Center and Dean of the School of Medicine, New York University (USA)
- Professor Dr. Bror Rexed, Director General of the "Socialstyrelsen" (Sweden)
- Dr. Hugo Thiemann, Director General of the Battelle Institute of Geneva (Switzerland).

The Background Report was prepared by Mr. François Hetman - who dealt in particular with questions relative to the allocation of R and D resources and the economic aspects - in collaboration with Mr. Gilbert Caty who studied the role of Universities and Mr. Georges Ferné who wrote the part devoted to institutional problems.

ACKNOWLEDGEMENTS

The Examiners and the Directorate for Scientific Affairs wish to express their thanks to the Netherlands authorities and government officials for their invaluable assistance in the preparation of this report.

It would be impossible to thank all those who helped in this exercise. However, the Examiners and the OECD owe a particular debt of gratitude to the Director General for Science of the Ministry for Science Policy and University Education, the President of the Science Policy Council, the Directors of the Organisation for the Advancement of Pure Research, the Netherlands Organisation for Applied Scientific Research and to the Netherlands University Council who took a personal interest in the proceedings and enabled the Examiners and the Rapporteur to obtain a clear picture of science policy problems in the Netherlands.

Special thanks are due to the representatives of ministries, professional organisations, universities and industry for their valuable contributions to the success of the investigation of the Examiners and of the Rapporteur.

Book I

BACKGROUND REPORT

19-20

INTRODUCTION

One of the major characteristics of Dutch society before the Second World War had been a tendency towards denominational splitting, i.e. towards the creation of numerous social, political and cultural organisations on some particular denominational grounds. This tendency was most pronounced in the field of education. Though it seemed to run counter to broad currents of modern societies, many of these organisations survived the war, notably the denominational political parties and the denominational trade unions.

However, in the period immediately following the Second World War there arose an urgent need for a concerted effort, firstly to rebuild many areas of the country, then to promote industrialization and hasten the transformation of the economic and social structure. It was assumed that all organisations should be involved in this effort and combine their resources.

New institutional bodies were created to facilitate co-operation between different economic levels and organisations, and between various social partners, such as employers and employees, etc. Best-known examples were the Joint Industrial Labour Council and the Social and Economic Council. A high degree of industrial peace is considered to be one of the results of this development, at least during the first decade after the War. At the same time the social security system was expanded and modified. Till then, the basic aim had been to provide aid to groups at a social disadvantage. Thenceforward, emphasis was laid on achieving a minimum of social security for each individual. A minimum income was fixed by law and the National Assistance Act came into existence.

In recent years the Netherlands has been undergoing a rapid process of transmutation. The call for direct participation and a more democratic way of decision-making has made most headway in the universities. It has also spread in other areas, such as industry and trade, where a series of new laws has been enacted to promote entrepreneurial and industrial relations. In the political arena some existing political parties have undergone considerable changes.

The major concern at present is to establish henceforth a new meaningful relationship between economic growth and social welfare. From all sides increasing criticism can be heard against one-sided and narrow conceptions of economic and technical progress. It is generally admitted that the Netherlands will have to devise new forms of organisation and information channels to meet the host of new aspirations of the national community. One trend - supported in particular by government agencies - is an extension of programming and planning to areas of social matters. Another is to draw more intensively on the scientific community and on research in order to help clarify national goals and to bring science into the very heart of political organisation and the decision-making process.

Part One

THE SCALE AND DYNAMICS OF R AND D ACTIVITY

I

R AND D POTENTIAL AND ACTIVITIES

"The evolution of science policy in the Netherlands can only be understood against the country's historical background and its nationally characteristic ways of thinking.

"The Netherlands have largely been wrested from the sea and this has caused the Dutch character to be very conservative on the one hand, and progressive and enterprising on the other. As a result, it is common in the Netherlands to found new institutions while the old ones are left to work unchanged. Frequently, old and new institutions will be found running parallel. The outcome is usually a structure of great complexity.

"It should be added that seafaring experience moulded the tradition of the Netherlands as a commercial country. The commercial mentality rules the national style, and it will be found underlying many aspects of science and science policy. In addition to this, there is the country's love of liberty. It has historical roots in the Reformation, Lutheran as well as Calvinist. The older religions (especially the Roman Catholic) have, however, continued to exist. This has resulted in great mutual respect which is expressed in the deep respect one finds in the Netherlands for many different styles, opinions, solutions and approaches to most problems, even the problems of scientific policy".

H.W. Julius
Former Chairman, Netherlands Central Organisation for
Applied Scientific Research (TNO)
Minerva, Vol. V., No. 4, Summer 1967.

1. THE RESEARCH POTENTIAL

From the very beginnings of modern science the Netherlands has been a major centre for scientific endeavour. Some of its universities and scientific communities have risen rapidly to international fame and today education and research in the Netherlands' institutes of higher education is in general of a high standard.

Traditionally, the Netherlands' higher education has been considered one of the most outstanding in Europe. Its basic characteristics seem to be a general call for open-mindedness, a tolerant attitude towards new ideas, with particular stress on both the humanitarian and practical aspects of scientific research and its results.

This feature - that the Dutch people themselves explain by the perennial state of awareness necessitated by the struggle for soil and space - has undoubtedly facilitated the transition from academic science to organised R and D activities as they began to emerge at the beginning of the twentieth century. However, as in other industrial countries, it was not until after the second World War that a conscious and systematic approach to science policy and its economic and social consequences was introduced.

a. Total expenditure on R and D

For the Dutch, research in the broad sense has been an intrinsic part of their efforts to secure national identity and economic development. For centuries they have been accustomed to planned management of water and reclaimed soil and to looking overseas for new outlets for their products and services. The drive for innovation has become a major element in their competitiveness, especially as it has been directed more and more consciously to the discovery of new "niches" in international markets.

The development of big multi-national companies and some governmental laboratories indicated that R and D had already attained a certain level of importance in the first few decades following World War I. However, no figures are available for that period.

After the Second World War some attempts were made to estimate expenditure on R and D. In the general framework for its economic projections, the Central Planning Bureau suggested a figure of 30 to 35 million guilders for the year 1947, including expenditure on social sciences.

Another evaluation was undertaken for the year 1949, under the sponsorship of the Prins Bernhard Fonds, in the field of R and D expenditure on natural and social sciences outside the business enterprise sector. According to this estimate the expenditure amounted to 65 million guilders. In 1951 the Central Bureau of Statistics conducted a survey of R and D expenditure in the business enterprise sector for the year 1950, and indicated an amount of approximately 100 million guilders for both natural and social sciences. For the year 1950 the overall estimate reached the sum of 165 million guilders, which represented broadly 0.9% of the gross national product at factor cost in the same year.

In 1957 the Central Planning Bureau published a new estimate for the year 1955: this amounted to circa 200 million guilders or nearly 1% of the gross national product at factor cost.

However, the first systematic general survey relates to 1959. It was undertaken by the Central Bureau of Statistics and included the natural sciences and engineering. This same institution carried out another survey for the year 1964 in connection with the International Statistical Year organised by the OECD. This survey included both natural sciences and engineering and also social sciences. The Central Bureau of Statistics had participated since 1967 and 1969 in the statistical surveys realized according to the definitions of the "Frascati Manual" and the general procedure accepted by all Member countries of the OECD. As can be expected these data for bench-mark years 1959, 1964, 1967 and 1969 are not entirely homogeneous and should be compared with a certain amount of reserve.

Another source of information and figures on R and D expenditure is the series of "research budgets" set up annually from 1966 onwards (with the exception of 1968) by the Ministry of Education and Sciences. Based on the definitions of the Frascati Manual, the research budget gives a detailed view of the overall expenditure on R and D by the Government. Detailed budget estimates are available for the period 1964-1971.

In addition, under the responsibility of the OECD, experts from the Ministry of Education and Sciences elaborated a series of actual expenditure on R and D in the public sector back to 1959. From these data an overall estimate can be made for the period 1964-1971 and with the aid of intrapolation an approximate picture can be drawn for the years 1959-1972 in respect of total expenditure and both the Government and business enterprise's share of R and D funds.

As may be seen from Table 1, total R and D expenditure at current prices amounted to about 500 million guilders in 1959, rose to 1,112 million guilders in 1964 and was estimated at 2,853 million guilders in 1971. This last figure is about five times that quoted in the first survey in 1959.

Although the existing figures are not fully consistent, the shape of the curve of the total government R and D expenditure since 1950 has a clear S-form (Graph 1). In 1955 this expenditure was only 1% of total government expenditure and has increased up to almost 4% in 1966. In the following years this percentage was unchanged.

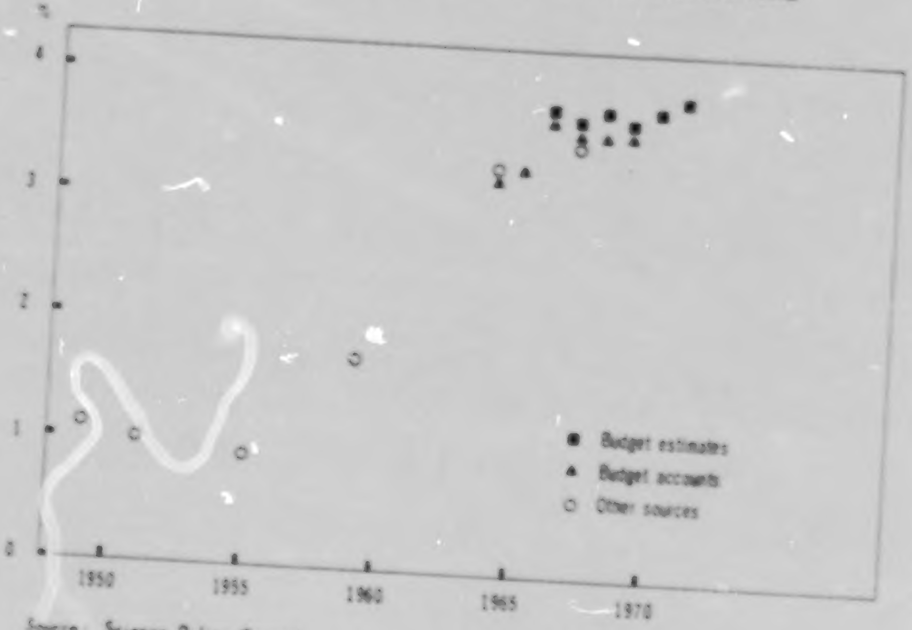
The period from 1959 to 1966 was characterized by particular high rate of growth, approaching an average of about 18% per year.

Because of the steady growth rate of the R and D expenditure in the business enterprise sector, the curve of the total R and D expenditure as per cent of GNP is also seen to have an S-shape.

The period from 1959 to 1966 was characterized by a particularly high rate of growth of total R and D expenditure, approaching an average

Graph 1

GOVERNMENTAL EXPENDITURE ON R & D AS PERCENTAGE OF TOTAL GOVERNMENTAL EXPENDITURE



Source: Science Policy Council.

Table 1. ESTIMATED EXPENDITURE ON R AND D OF THE BUSINESS ENTERPRISE SECTOR (FINANCED OUT OF OWN MEANS) AND OF THE GOVERNMENT

Million guilders

	1959	1964	1965	1966	1967	1968	1969	1970	1971	1972
Business enterprise sector	366	546	757	887	1,039	1,167	1,308	1,468	1,647	1,847
Government (including universities)	177	466	567	636	716	841	935	1,071	1,206	1,330
Total	543	1,112	1,324	1,523	1,523	2,008	2,243	2,539	2,853	3,177
As percentage of Gross National Product	1.4	1.8	1.9	2.0	2.1	2.2	2.2	2.3	2.3	2.3

of 18.5% per year. The following period (1966-1971) was marked by a slower annual rate of growth, averaging 14% per year.

From 1959 to 1966, the growth rate of total R and D expenditure was almost twice that of the gross national product at current prices. It was still some 50% above the latter during the period 1966-1971. Expressed as a percentage of the gross national product at current prices, the ratio of total R and D expenditure was 1.4% in 1959. It reached the 2% mark in 1966 and continued to rise regularly until it reached 2.3% in 1971.

This trend is all the more striking as the level of total R and D expenditure was already relatively high in 1959, and particularly since 1966, when the Netherlands joined the group of the most advanced nations in this field.

b) Personnel employed in R and D activities

As in many other countries, information on manpower employed in R and D activities is relatively scarce. The surveys realized in 1959, 1964 and 1967 give an estimate of total R and D personnel in natural sciences and engineering. Two categories are distinguished: full-time and part-time.

If both categories are considered together, there were 39,400 persons employed in R and D activities in 1959. The corresponding figure for 1964 was 56,910 and for 1967, 64,600 (cf. Table 2).

It is impossible to say how far the figures of these three surveys are comparable, particularly as far as concerns the higher education sector where major changes seem to have occurred. This is probably due to differences in interpretation of full-time and part-time activities rather than to a sudden regression in numbers of persons employed full-time.

Admitting that the three surveys give a rough picture of the general trend where total numbers are concerned, the growth rate of total R and D personnel can be estimated at some 7% between 1959 and 1964 and to some 4% for the period 1964-1967.

The overall rate of growth seems to have been particularly rapid in the business enterprise and the higher education sectors. The number of full-time R and D personnel in the business enterprise sector grew considerably from 1959 to 1964 and this notwithstanding reservations that may be made as to the number and relative importance of corporations surveyed. Part-time R and D personnel in the higher education sector

Table 2. R AND D PERSONNEL BY SECTOR OF PERFORMANCE
(natural sciences and engineering)

	BUSINESS ENTERPRISE	GOVERNMENT AND NON-PROFIT ORGANISATIONS	HIGHER EDUCATION	TOTAL
1959				
Full-time	16,500	6,750	760	24,010
Part-time	7,100	2,550	5,740	15,390
Total	23,600	9,300	6,500	39,400
1964				
Full-time	24,880	8,690	440	34,010
Part-time	7,660	3,030	12,210	22,900
Total	32,540	11,720	12,650	56,910
1967				
Full-time	27,000	11,100	500	38,600
Part-time	8,100	2,400	15,500	26,000
Total	35,100	13,500	16,000	64,600

SOURCE: Central Bureau of Statistics (CBS): Survey
Speur-en ontwikkelingswerk in Nederland in 1967.

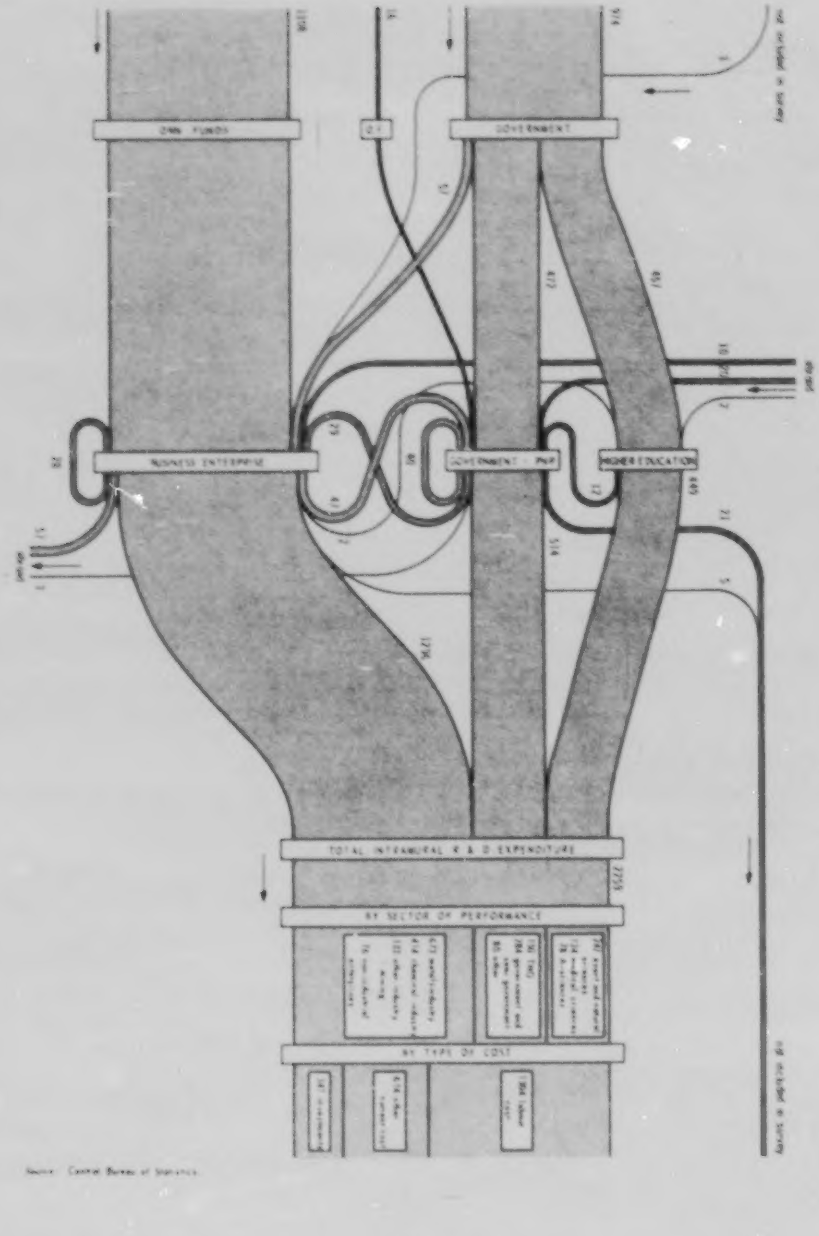
apparently more than doubled between 1959 and 1964 and also increased considerably during the period 1964-1967. This development is closely linked to the rapid expansion of higher education where the principle of unity in teaching and research does not permit a clear-cut distinction between the two activities, so that research activity is generally estimated as a fixed percentage of the overall work schedule.

In these conditions a closer analysis of these figures would not make much sense. There is no doubt that R and D personnel increased substantially during the 1960s, in line with the rapid increase in R and D expenditure and the overall government effort in favour of R and D activities. However, the available figures do not allow for a comparison between the two series and for an eventual examination of the trend of R and D expenditure per person employed in R and D activities.

Chart 1

FLOW OF R & D FUNDS

1969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BUSINESS ENTERPRISE
GOVERNMENT - PNP
HIGHER EDUCATION
TOTAL INTRAMURAL R & D EXPENDITURE
BY SECTOR OF PERFORMANCE
BY TYPE OF COST
1108
16
974
57
412
451
23
41
80
22
12
685
21
5
514
1276
2755
10
2
1
abroad
not included in survey

Source: Central Bureau of Statistics

The 1967 figures have also been classified to fit into the standard OECD classification. Converted into full-time equivalents, they indicate a total of 50,200 persons engaged in R and D activities.

According to Table 3 there were 15,700 scientists and engineers in 1967 employed in full-time R and D activities. This was about 30% of the total R and D personnel. No separate figures were available for technicians on one hand and other supporting staff on the other.

Table 3. R AND D PERSONNEL BY LEVEL OF QUALIFICATION AND BY SECTOR OF PERFORMANCE

Full-time equivalent
Year 1967

	SCIENTISTS AND ENGINEERS	TECHNICIANS	OTHER SUPPORTING STAFF	TOTAL
Business enterprise	8,000	21,700		29,700
Government	590	1,140		1,730
Non-profit institutions	4,210	6,360		10,570
Higher education ...	2,900	5,300		8,200
Total	15,700	34,500		50,200
As percentage of the total				
Business enterprise	51	63		59
Government	4	3		3
Non-profit institutions	27	19		21
Higher education	18	15		17
Total	100	100		100

SOURCE: CBS Survey, Speur-en ontwikkelingswerk in Nederland in 1967 and OECD classification and estimates.

About 60% of all R and D personnel were employed in the business enterprise sector, 21% in the non-profit institutions, 17% in the higher education sector and 3% in government agencies. The distinction between the government sector and the sector of non-profit institutions is made essentially on an institutional basis and may seem rather arbitrary, as the major part of the non-profit institutions are government "foundations", more or less fully supported by the public authorities.

For scientists and engineers the breakdown is slightly different. One out of every two of these highly qualified persons is employed in the business enterprise sector, 31% in the non-profit institutions and the government sector, 18% in the higher education sector.

As far as the overall numbers are concerned, the breakdown seems to coincide largely with that of overall R and D expenditure as will be seen later in Chapter II, on patterns of performance, funding and types of research.

2. THE NETHERLANDS R AND D EFFORT IN AN INTERNATIONAL CONTEXT

International comparisons of R and D effort have been so far based on a small number of indicators which mainly compare R and D expenditure and R and D personnel both in absolute figures and in relation to macro-economic and macro-social magnitudes such as the gross national product, the total population or the civilian labour force.

It must be remembered that all these figures are subject to explicit reservations as to the degree of comparability. Methods of evaluating R and D expenditure still differ considerably from one country to another. Calculations of gross national product data continue to be dependent on the national system of aggregates and on methods of weighting their main components. Conversion of money values at official exchange rates must be considered as very tentative as it cannot reflect relative price levels and the actual purchasing power of national currencies.

The figures and calculations in comparative tables and charts should be regarded as approximate magnitudes rather than precise measurements, particularly in the case of ratios relating R and D expenditure or R and D personnel to macro-economic aggregates.

a) Gross national expenditure on R and D

The first element of comparison is the total amount of gross expenditure on R and D which can be regarded as a very rough indicator of a country's overall research potential. On this criterion the Netherlands came eighth in the 1963/65 comparative table and seventh in the 1967 statistical survey of the OECD countries. It thus came immediately after countries whose population and gross domestic product are higher by far than those of the Netherlands. Broadly speaking it amounted to a fourth of the amount devoted to R and D by Germany and to a fifth of the French or the British total expenditure.

However this type of comparison remains subject to many caveats, both intrinsic and methodological. It does not reveal the real importance of R and D activities in the national frame-work as compared with other aspects of the economic and social situation of a country.

b) R and D related to the gross national product

The relative importance of R and D expenditure can be expressed more suitably as a ratio of the gross national product. This gives an idea of a country's R and D effort in proportion to its current domestic production and overall economic situation.

The table for the years 1963/1965 shows that in relative terms the Netherlands shared third place with France among the OECD countries, after the United Kingdom, with 2.3%, and the United States with 3.4% of gross national product.

The 1966/67 international statistical year yielded practically the same ranking, the Netherlands being on a level with France, following the United Kingdom and the United States. However, with a figure of 2.3%, the Netherlands improved its relative position in comparison with the United Kingdom (2.4%) and the United States (3.1%) as well as with most of the other OECD countries.

c) R and D expenditure and gross national product per capita

Another approach is to consider the relation between total R and D expenditure expressed as a percentage of the gross national product and the gross national product per capita calculated in United States dollars. Here again the latter figure must be considered as a rough approximation.

If two envelope lines are traced to delineate the possible relationship between the two magnitudes it appears that the Netherlands have the best relative position among the OECD countries; in other words that it spends more than any other OECD country in relation to its gross national product per capita, or that it has the highest relative expenditure per dollar of gross national product per capita.

Table 4. GROSS NATIONAL EXPENDITURE ON R AND D IN THE OECD COUNTRIES 1963/1965

	GROSS NATIONAL R AND D EXPENDITURE		AS A PERCENTAGE OF GROSS NATIONAL PRODUCT AT MARKET PRICES
	MILLION NATIONAL CURRENCY UNITS	MILLION US $	
United States (1963/64) . .	21,075.0	21,075.0	3.4
United Kingdom (1964/65)	771.4	2,159.9	2.3
France (1964)	7,950.0	1,650.0	1.9
Netherlands (1964)	1,196.0	330.0	1.9
Switzerland (1964)	870.0	203.0	1.6
Sweden (1964)	1,331.6	257.0	1.5
Japan (1964/65)	381,600.0	1,060.0	1.5
Germany (1964)	5,745.1	1,436.3	1.4
Canada (1965)	680.0	630.5	1.3
Belgium (1963)	6,841.7	137.0	0.9
Norway (1963)	303.2	42.4	0.8
Italy (1965)	221,150.0	356.7	0.6
Ireland (1963)	3.7	10.5	0.5
Turkey (1964)	247.4	27.5	0.4
Austria (1963)	602.9	23.2	0.3
Spain (1964)	1,861.7	31.0	0.2
Portugal (1964)	265.8	9.0	0.2
Greece (1964)	237.6	7.9	0.2

SOURCES: International Statistical Year for Research and Development.
Canada, France, Italy, Japan: national statistics.
Switzerland: evaluation by the Secretariat.

d) Civilian R and D expenditure

It is well-known fact that the overall R and D effort has been greatly enhanced by considerations of national security and international prestige. In several countries the strengthening of national defence and military potential leads to a rapid expansion of research for military purposes. Though this category of research is expected to be instrumental in contributing to innovative processes in a country, its aims are not directly related to economic growth. In order to analyse the role of research in the advancement of the economic system, it may therefore be enough to isolate military research and to consider only civilian R and D expenditure.

It is difficult to distinguish statistically between the two categories, as criteria and accounting practices may vary from one country to another. Notwithstanding its inherent limitations, this kind of approach may prove useful, in particular in comparing countries whose military ambitions and research activities are modest if not negligible.

The orders of magnitude obtained by this approach give a rather different picture of the R and D effort expressed as a percentage of the gross national product.

On the basis of civilian R and D expenditure, the percentage of the gross national product devoted to the research effort is highest in the United States, but the Netherlands reaches practically the same relative level with somewhat less than 2. 2%. It is thus far ahead of other OECD Member countries, including the most highly industrialized ones such as the United Kingdom, Germany, France and Japan.

e) Total R and D personnel, qualified scientists and engineers

On many counts the number of persons engaged in R and D activities appears to be the most appropriate indicator of research potential of a country. However in the present state of statistics, it does not allow for an accurate assessment of research endeavour. An international comparison runs up against many difficulties. Only fragmentary data are available so far, and these are not always fully homogeneous, as notable differences persist in methods of assessing the time actually devoted to research and to express it in full-time equivalents.

Though no far-reaching conclusions can be drawn from these figures, they seem to confirm broadly the relative orders of magnitude obtained by comparisons of R and D expenditure.

According to the 1967 statistical survey the total R and D personnel in the Netherlands was estimated at 50,200 or 1. 1% of the total civilian labour force.

Table 5. R AND D EXPENDITURE AS A PERCENTAGE OF GROSS NATIONAL PRODUCT

COUNTRY	YEAR	GROSS NATIONAL EXPENDITURE ON R AND D	GROSS NATIONAL PRODUCT[1]	GROSS NATIONAL EXPENDITURE ON R AND D AS A PERCENTAGE OF GROSS NATIONAL PRODUCT
		NATIONAL CURRENCY (MILLIONS)	NATIONAL CURRENCY (THOUSAND MILLION)	
United States	1966	23,613.0[2]	760.49	3.10
France	1967	12,375.8	537.71	2.30
United Kingdom	1967	941.8	39.62	2.38
Germany	1967	8,337.3	483.90	1.72
Japan	1967	606,295.0	41,638.00	1.46
Canada	1967	895.5	61.97	1.45
Netherlands	1967	1,860.0	82.27	2.26
Italy	1967	279,453.0	41,849.00	0.67
Sweden	1967	1,709.3	123.77	1.38
Switzerland	1967	1,315.5	68.94	1.91
Belgium	1967	8,800.4	977.10	0.90
Denmark	1967	636.9	84.26	0.76
Norway	1967	576.5	59.46	0.97
Austria	1967	1,616.3	276.50	0.58
Finland	1967	170.4	29.90	0.57
Ireland	1967	6.1	1.13	0.54
Greece	1967	338.7	213.39	0.16

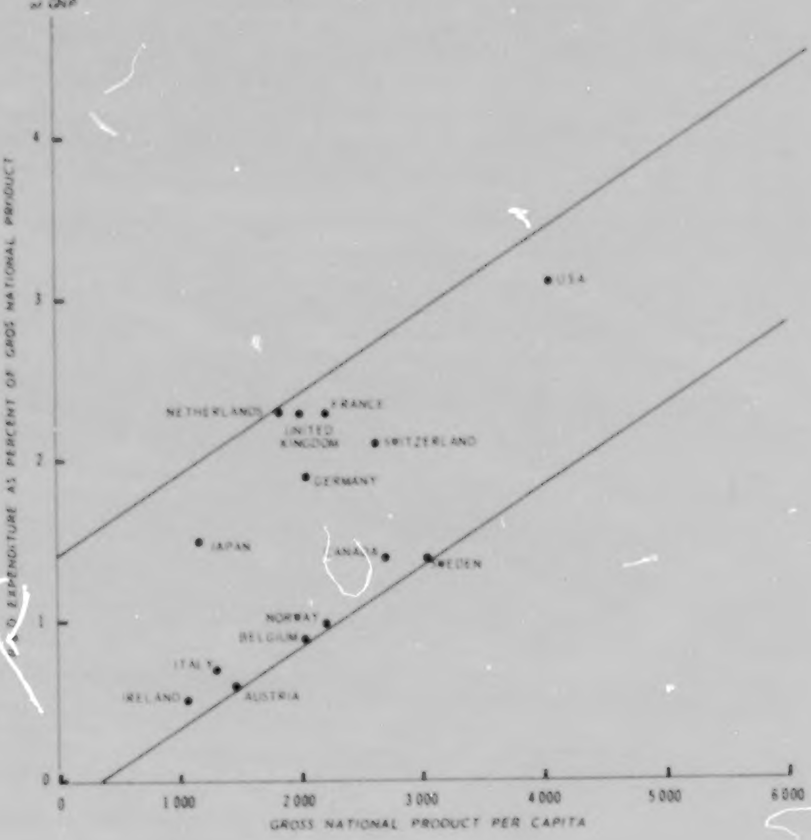
1. Gross national product at market prices.
2. Including depreciation but not capital expenditure in the industrial sector.

SOURCE: OECD survey of the resources devoted to R and D activity by OECD Member countries in 1967.

Graph 2

RELATION BETWEEN R & D EXPENDITURE AND GROSS NATIONAL PRODUCT PER CAPITA

1967



Source: OECD Secretariat.

On this criterion of relative importance to the total civilian labour force, the Netherlands comes immediately after the United States, preceding all other OECD countries.

Table 6. CIVIL R AND D EXPENDITURE AS PER CENT OF THE GROSS NATIONAL PRODUCT

COUNTRY	YEAR	TOTAL R AND D EXPENDITURE	CIVILIAN R AND D EXPENDITURE
United States	1966	3. 1	2. 2
Netherlands	1967	2. 2	2. 15
United Kingdom	1966/67	2. 4	1. 7
France	1967	2. 3	1. 6
Germany	1967	1. 8	1. 5
Japan	1967	1. 5	1. 4
Canada	1966	1. 3	1. 1
Norway	1967	1. 0	0. 9
Belgium	1967	0. 9	0. 85
Italy	1967	0. 7	0. 65
Ireland	1967	0. 6	0. 6
Austria	1966/67	0. 6	0. 6
Greece	1966	0. 2	0. 2

SOURCE: OECD and Wetenschapsbudget 1971, Table 13.

A very similar pattern is obtained by looking at the ratio of qualified scientists and engineers to the total civilian labour force. In relative terms, the Netherlands rank a considerable way behind the United States but in front of all other OECD countries.

It may be argued that the Netherlands estimate of R and D personnel is rather high in comparison to relative figures on R and D expenditure. This may be due to difficulties in computation of full-time equivalents, in particular in the higher education sector.

Table 7. R AND D MANPOWER, QUALIFIED SCIENTISTS AND ENGINEERS

COUNTRY	YEAR	TOTAL R AND D MANPOWER	QUALIFIED SCIENTISTS AND ENGINEERS	CIVILIAN LABOUR FORCE (IN THOUSANDS)	TOTAL R AND D MANPOWER AS A PERCENTAGE OF CIVILIAN LABOUR FORCE	QUALIFIED SCIENTISTS AND ENGINEERS AS A PERCENTAGE OF CIVILIAN LABOUR FORCE
United States	1966	(1,375,000)[1]	524,776	74,372	1.65	0.71
France	1967	193,457	49,224	19,588	0.99	0.25
United Kingdom	1967	(228,000)[1]	(63,000)[1]	24,996	0.91	0.25
Germany	1967	205,866	61,559	25,803	0.80	0.24
Japan[2]	1967	356,275	157,612	49,350	-	-
Canada	1967	51,790	19,350	7,379	0.70	0.26
Netherlands	1967	50,200	15,700	4,407	1.14	0.36
Italy	1967	49,939	19,670	18,920	0.26	0.10
Sweden	1967	25,172	6,605	3,734	0.67	0.18
Switzerland	1967	(21,000)[1]	10,954[3]	2,705	0.78	-
Belgium	1967	19,750	7,945	3,616	0.55	0.22
Denmark	1967	8,378	3,919	2,274	0.37	0.17
Norway	1967	7,357	2,958	1,505	0.49	0.20
Austria	1967	6,620	2,401	3,241	0.20	0.07
Finland	1967	5,154	2,026	2,142	0.24	0.09
Ireland	1967	2,800	1,121	1,055	0.27	0.11
Greece	1967	2,730	1,217	3,610	0.08	0.03

1. Estimate by the Secretariat.
2. Full-time equivalents not available.
3. Including technologists (ingénieurs-techniciens).

SOURCES: International Survey of the Resources devoted to R and D in 1967 by OECD Member countries, OECD Document DAS/SP/70,9, Vol. 5. Statistics of Active Population 1956-67, OECD, Paris, 1969.

II

PATTERN OF R AND D EFFORT

The basic feature of the Netherlands pattern of R and D effort is a clear-cut definition of the respective roles of the business enterprise sector and the Government, both as sectors of performance and sources of funds. In the business enterprise sector performance and financing are practically identical and the sector's own funds cover almost the totality of expenditure.

Government prefers to refrain from performing R and D and to act through intermediate bodies and institutions in order to combine the advantages of bringing scientists to assume extended responsibilities with more distant and yet efficient administrative supervision.

Governmental funds finance the bulk of R and D expenditure in the higher education sector, which preserves autonomy as regards the choice of research projects and programmes.

Its financial sponsorship remains by over ninety per cent the basic source of funds of big research organisations created to promote research and development in fields of general character or of a particular interest to the community.

1. R AND D EXPENDITURE BY SECTOR OF PERFORMANCE

The statistical surveys carried out for several bench-mark years by the Central Bureau of Statistics and the estimates by the Ministry of Education and Sciences make it possible to analyse the structure of R and D activities during the period 1959-1971.

The Netherlands statistical material allows for a distinction between natural sciences and engineering on the one hand and social sciences and humanities on the other. From 1959 to 1971, the total amount of R and D expenditure at current prices sectupled in the field of natural sciences and engineering, whereas there was a ten-fold increase in the domain of social sciences and humanities.

However, this latter category is still relatively small. In 1959 its share of overall R and D expenditure was 3.3%. It rose regularly during the 1960s, attained 5.4% in 1967 and was estimated at 6.5% in 1971.

In 1971 some three-fifths of total R and D in social sciences and humanities were performed in the higher education sector and the remaining two-fifths in the governmental sphere, including contributions to different international organisations.

The bulk of R and D activities continues to take place in natural sciences and engineering (93.5% of the overall R and D expenditure in 1971 as against 96.7% in 1959). At current prices the expenditure in this field rose from about 500 million guilders in 1959 to about 2,800 million guilders in 1971, which indicates a rapid and remarkably sustained rate of growth during this period.

a) Business enterprise sector

The figures available show a regular steady increase in R and D activities in the business enterprise sector. They suggest an average annual growth rate of about 15% for the period 1959-1971. At current prices, total funds spent on intra-mural R and D activities rose from 336 million guilders in 1959 to 1,055 million guilders in 1967, and to an estimated 1,590 million guilders in 1971. *

The share of the business enterprise sector in overall R and D expenditure (natural sciences and engineering plus social sciences and humanities) accounted for 62% in 1959. It dropped to 58% in 1964 and 53% in 1967, and rose again to 57% in 1971.

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* It has [illegible] be remarked that in these figures the R and D of enterprises with 10-50 persons are excluded. In its surveys of 1959, 1964 and 1967 the Central Bureau of Statistics has estimated the intra-mural R and D of these small enterprises at respectively 8 million, 15 million and 25 million guilders. In reviewing these data the Central Bureau of Statistics doubted the reliability of these last mentioned figures. Therefore, these enterprises are excluded from the results of the 1969 survey. In order to make the data comparable in the case of historical series figures for enterprises with 10-50 persons are excluded.

An exception are the tables in which only the year 1967 is mentioned, because the Central Bureau of Statistics had reported for 1967 to the OECD data inclusive of enterprises with 10-50 persons.

The changes in the relative importance of this sector are almost entirely attributable to the modifications in the growth rates of other sectors and in particular to two distinct phases in governmental policy, characterized by a very rapid expansion until 1966 and a more balanced growth from then until 1971.

It may be assumed that the steady growth of R and D activities in the business enterprise sector was at least partly stimulated by shifts in the size pattern of firms. There seems to be more and more evidence that these must reach a certain minimal threshold in order to profit from research activities. On the average, the intensity of research tends to grow with the size of the firm. According to the 1964 survey by the Central Bureau of Statistics, there was quite a difference between small, medium-sized and large societies. In firms employing 10-99 persons, about 1% of the staff was engaged in R and D activities, in those with 100-999 employees 1.3%, and in those employing more than 1,000 persons the figure was 3.6%.

In 1959 about 35% of industrial manpower were working in firms employing more than 1,000 employees. This percentage rose to 41% at the end of 1968. However, no single figure can show fully the extent of concentration which took place during the 1960s and has continued since as is shown by the enduring tendency to merge and to pool both productive and innovative resources.

b) Public sector

As has been shown in Graph 1 government expenditure on R and D increased rapidly. During the period 1959-1966, in particular, its growth rate was much more rapid than that of the business enterprise sector. From 1966 to 1971, the rate of increase slowed down, partly as a consequence of the previous expansion and partly through changes in policy priorities.

The breakdown by main directions of allocation makes it clear that the trends were more irregular in nuclear, space and defence R and D and in contributions to international organisations than in funds devoted to economic and social fields of research.

Military R and D increased rapidly in the years 1959-1964, mostly because of implications of weapon procurement procedures within the framework of NATO and the need to devote an increasing amount of national defence budget to research and development tasks in order to follow the general tendency to scientification and sophistication in new strategic and deterrent devices.

Table 8. TOTAL EXPENDITURE ON R AND D BY SECTOR OF PERFORMANCE

	MILLION GUILDERS			
	1959	1964	1967	1971
A. Natural sciences and engineering				
Business enterprise	336	649	1,055	1,590
Government[1] excluding higher education, international organisations, defence, nuclear and space R and D	59	96	171	361
Government[1] nuclear, space and defence R and D	26	91	147	180
Government[1] contributions to international organisations	9	34	59	53
Higher education government expenditure in this sector	61	194	283	426
Total natural sciences and engineering	491	1,064	1,715	2,610
B. Social sciences and humanities				
Government[1] excluding higher education sector but including contributions to international organisations	7	19	34	84
Higher education government expenditure in this sector	10	32	65	102
Total social sciences and humanities	17	51	99	186
Total A + B	508	1,115	1,814	2,796

[1] Comprising also more or less independent foundations mainly financed by government. In the figures for the business sector are also comprised some amounts which are financed by government. These amounts are Fl. 7 million for 1964, Fl. 10 million for 1967 and Fl. 59 million for 1971.

SOURCES: Ministry of Education and Sciences and OECD.

Table 9. TOTAL EXPENDITURE ON R AND D BY SECTOR OF PERFORMANCE

	PERCENTAGE OF TOTAL			
	1959	1964	1967	1971
A. Natural sciences and engineering				
Business enterprise	66.7	58.8	58.7	57.6
Government excluding higher education, international organisations, defence, nuclear and space R and D	11.4	8.5	9.3	12.7
Government nuclear, space and defence R and D	5.0	8.0	8.0	6.3
Government contributions to international organisations	1.8	3.0	3.2	1.9
Higher education government expenditure in this sector	11.8	17.2	15.4	15.0
Total natural sciences and engineering .	96.7	95.5	94.6	93.5
B. Social sciences and humanities				
Government excluding higher education sector but including contributions to international organisations	1.4	1.7	1.9	2.9
Higher education government expenditure in this sector	1.9	2.8	3.5	3.6
Total social sciences and humanities ..	3.3	4.5	5.4	6.5
Total A + B	100	100	100	100

SOURCES: Ministry of Education and Sciences and OECD.

During the same period, R and D expenditure rose steeply in the fields of nuclear physics and energy, space and space technology. The main reason was that in 1959 this kind of research was still in its take-off stage in the Netherlands. As far as nuclear physics is concerned, it was also stimulated in the first stage of development of Euratom. Once adequate facilities had been built the rate of growth of the resources devoted to these fields slowed down and some programmes were reduced or discontinued. This explains the fact that part of the overall expenditure on R and D devoted to nuclear research, space and defence increased from 5% in 1959 to 8% in 1964 and 1967, but dropped to 6.3% in 1971.

This situation also reflects the growing difficulties in going on with projects of international co-operation in the domain of nuclear and space research. These difficulties explain, too, the cutting down of the contributions to international organisations. This amount increased rapidly until 1967; in that year it reached 3.2% of the overall expenditure on R and D. However its relative importance fell again to 1.9% in 1971. It must be pointed out in this connection that about 90% of the Netherlands contributions to international organisations have been intended for R and D work in nuclear physics and energy, and in space exploration and technology.

All other fields of governmental or public sponsored R and D, registered a sustained growth rate during the period 1959-1971. They practically maintained their share in the overall expenditure on R and D with 11.4% in 1959 and 12.7% in 1971.

When all categories of governmental or public sponsored R and D in natural sciences and engineering are added together, they amount to about 21% of overall R and D expenditure in 1971 as against about 20% in the bench-mark years 1964 and 1967, but slightly more than in 1959. This seems to hint at a close link between the pattern of economic development and an accompanying rather than intervening role in public policy.

c) Higher education

The higher education sector has been the most dynamic one during the period 1959-1971. According to the estimates by the Ministry of Education and Sciences, the expenditure on R and D in natural sciences and engineering rose from 61 million guilders in 1959 to 426 million guilders in 1971, that is about seven times more. Accordingly, the share of higher education in the overall expenditure on R and D jumped from 11.8% in 1959 to 17.2% in 1964, but tended to drop again somewhat in the following years to 15% in 1971.

In social sciences and humanities the rate of growth in R and D expenditure was still higher; the total amount rose from 10 million guilders in 1959 to 100 million guilders in 1971, and the relative importance of this type of research increased from 1.9% in 1959 to 3.5% in 1967 and levelled off to 3.6% in 1971.

The estimates for the various bench-mark years are subject to reservations. The figures for 1959 and 1964 are based on the surveys carried out by the Central Bureau of Statistics, using a different method in each case. The results of the 1969 survey were used in the 1967 and 1971 evaluations. The figures for 1967 resulted by interpolation from the 1964 and 1969 data. The ratios calculated in 1969 were used again in the 1971 evaluation. In other words, it was assumed that R and D activities in the period 1969-1971 represented a fixed proportion in the higher education sector.

Such a straightforward method related R and D directly to the expansion of the higher education sector as a whole. It derives the increase of research from the teaching function and in the last analysis from the growing numbers of students. However, experience in other countries and comparison of the 1964 survey of the Central Bureau of Statistics with the 1969 survey suggest that the rapid expansion of students tends generally to augment the student/teacher ratio, increases thus the burden of teaching and simultaneously reduces the time and resources per student devoted to research.

2. R AND D EXPENDITURE BY SOURCE OF FINANCE

Statistics on the financing of R and D activities show two main sources of funds: the business enterprise sector and the government. Between the two the flow of transfers is negligible. As regards the business enterprise sector, the figures of funding are almost identical to those of intra-mural performance.

As is shown in Tables 10 and 11 other sources of finance account to about 4% of the total, half of which comes from abroad and the other half from non-profit institutions.

According to the OECD standard classification, all agencies with an independent legal status are included in the non-profit institutions sector, whereas the government sector includes only research organisations depending directly on a ministry or another public authority. The large public-sponsored research organisations like the Netherlands Organisation for Applied Scientific Research (TNO)* and the Organisation for

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* Nederlansche Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek, for which the abbreviation TNO is currently used.

Pure Scientific Research (ZWO)* in particular are thus included in the non-profit institutions sector. Consequently, this latter appears as a major performer several times more important than the government sector and not very far behind the higher education sector.

Table 10. R AND D EXPENDITURE FOR NATURAL AND ENGINEERING SCIENCES BY SOURCE OF FUNDS AND BY SECTOR OF PERFORMANCE
1967
(By OECD standard classification)

SOURCE OF FUNDS / SECTOR OF PERFORMANCE	BUSINESS ENTERPRISE	GOVERN-MENT	NON-PROFIT INSTI-TUTIONS	HIGHER EDUCATION	TOTAL
Business enterprise	1,017	-	22	-	1,039
Government	10	50	281	283	624
Non-profit institutions	13	-	7	-	20
Abroad	15	-	20	-	35
Total	1,055	50	330	283	1,718

SOURCE: CBS survey: Speur-en ontwikkelingswerk in Nederland 1967 revised by the Ministry of Education and Sciences in accordance with the provisional results of the CBS research-survey for 1969.

In 1967 almost 97% of the intra-mural R and D in the business enterprise sector was financed from the sector's own funds and a very small amount was financed by the Government (1.6%) and by sources abroad (1.4%). The business enterprise sector contributed to a fairly modest extent to the funding of R and D in the non-profit institutions (about 1.2% of total R and D funds of business firms).

More than 90% of the financing of the non-profit institutions was secured by governmental funds. A small amount was provided from abroad. Own funds accounted for a still smaller share, about 4% in the case of the ZWO but only about 1% in that of the TNO.

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* Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek, abbreviated as ZWO.

Table 11. TOTAL EXPENDITURE ON R AND D BY SOURCE OF FINANCE

1967

(As percentage of total)

	BUSINESS ENTERPRISE	GOVERNMENT	NON-PROFIT INSTITUTIONS	HIGHER EDUCATION	TOTAL
Breakdown of funds by receiving sectors					
- Own funds	96.4	-	6.7	-	
- Government ..	1.0	100.0	85.2	100.0	
- Non-profit institutions ..	1.2	-	2.1	-	
- Abroad	1.4	-	6.0	-	
Total	100.0	100.0	100.0	100.0	
Breakdown of funds by financing sector					
- Business enterprise	97.9	-	2.1	-	100.0
- Government...	1.6	8.0	45.0	45.4	100.0
- Non-profit institutions ...	65.0	-	35.0	-	100.0
- Abroad	42.9	-	57.1	-	100.0
Total intra-mural R and D	61.4	2.9	19.2	16.5	100.0

SOURCE: CBS Survey: Speur-en ontwikkilingswerk in Nederland 1967, and Ministry of Education and Sciences, Research in the higher education sector was financed entirely by the Government. This is consistent with the general institutional framework of the Netherlands system of higher education.

In 1967, about 45% of the government funding went to the higher education sector, 45% to various non-profit institutions and about 8% to government research units; only about 2% went to the business enterprise.

As regards the Government, its role as a source of funds is basically to secure the training of highly qualified personnel, the financing of R and D in the higher education sector and the financial sponsorship of an array of non-profit institutions. Big non-profit research institutions like TNO and ZWO were created on public initiative so that science could serve the community better. These bodies have a clearly defined autonomy and scientists with administrative experience share responsibility for their policy and direction with leading personalities from the private sector and with civil servants. An institutional framework such as this is considered to foster R and D in sectors where service to the community is the essential criterion and at the same time preserve some elementary supervisory powers for the Government.

Total R and D funding can be divided roughly as originating to three-fifths in the business enterprise sector and to two-fifths in the in the government sector. With some minor fluctuations, this breakdown has characterized the development from 1964 to 1971.

As is shown in Table 12 the importance of the business enterprise sector as a performer and as a source of finance is practically the same. In comparison with other countries, its share as a performer is less important than in the United States, the United Kingdom, Sweden, Germany, Belgium and Italy. However, as a source of funds its share in the total R and D effort is among the highest, on the same relative level as Belgium, Germany, Sweden or Japan.

3. EXPENDITURE ON R AND D BY TYPES OF RESEARCH

Given the difficulty of breaking down expenditure on R and D in three main categories corresponding to the definitions in the Frascati Manual, the Central Bureau of Statistics limited its 1967 and 1969 statistical survey to a simple division between research and development. These figures are not entirely comparable with those of the 1964 survey, which gave a separate account of fundamental research, applied research and development.

Table 12. ENTERPRISE AS A SECTOR OF PERFORMANCE BY SOURCE OF FUNDS AS PER CENT OF GERD

COUNTRY	YEAR	SOURCE OF FUNDS					
		BES	GOVERNMENT	PNP	HIGHER EDUCATION	FROM ABROAD	TOTAL
Austria	1963	53.8	8.5	0	0	1.2	63.5
	1967	57.6	5.2	0.1	0	0.5	63.4
Belgium	1963	64.1	3.3	0	0	1.6	69.0
	1967	59.2	4.4	1.5	0	1.7	66.8
Canada	1963	32.0	6.1	0	0	1.6	39.7
	1965	31.2	7.4	0	0	3.9	42.5
	1967	30.5	5.3	0	0	1.9	37.7
	1969	29.5	5.3	0	0	1.8	36.6
France	1961	31.5	15.5	0	0	0.3	47.3
	1963	32.6	14.8	0	0	1.5	48.9
	1965	30.2	18.8	0	0	2.5	51.5
	1967	30.2	20.6	0	0	2.3	53.1
Germany	1964	56.8	9.3	0	0	0.2	66.3
	1967	55.8	11.8	0.2	0	0.3	68.1
Greece	1964	15.8	0	0	0	0	15.8
	1966	33.05	0	0	0	0.45	33.5
Ireland	1963	26.1	2.8	0	0	0.2	29.1
	1967	34.2	0.7	0	0	0.5	35.4
Italy	1963	61.0	0.6	0	0	0.5	62.1
	1965	55.9	1.7	0	0	1.5	59.1
	1967	56.5	1.3	0	0	2.8	60.6
Japan	1963	56.1	0.2	0	0	0	56.3
	1967	53.2	0.5	0.1	0	0	53.8
Netherlands	1964	51.7	0.6	2.4	0	0.8	55.5
	1967	55.7	0.8	0.8	0	0.8	58.1
Norway	1963	37.0	12.2	1.0	0.2	1.3	51.7
	1967	36.6	12.3	0	0	1.1	50.0
Portugal	1964	17.8	0.6	0	3.3	0.4	22.1
	1967	15.4	0.7	0	0	0	16.1
Spain	1964	25.2	0	0	0	0	25.2
	1967	43.1	0.6	0	0.1	0.8	44.6
Sweden	1964	50.4	18.5	0	0	0.3	69.2
	1967	54.3	15.4	0.05	0	0.1	69.85
United Kingdom	1961	38.7	26.4	0	0	0.1	65.2
	1964	40.0	23.4	0	0	1.9	65.3
	1967	41.6	20.9	0	0	2.4	64.9
United States	1961	32.1	41.1	0	0	0	73.2
	1963	30.1	40.2	0	0	0	70.3
	1965	32.3	37.4	0	0	0	69.7
	1967	35.5	34.0	0	0	0	69.5
	1969	39.5	31.2	0	0	0	70.7

SOURCE: OECD: "R and D in OECD Member countries", Appendix, Table 3, July 1971.

According to Table 13 fundamental research and applied research amounted to 955 million guilders in 1967 and development to 905 guilders, that is, the overall expenditure on R and D was divided about equally between research and development.

Table 13. R AND D EXPENDITURE
BY TYPE OF ACTIVITY AND SECTOR OF PERFORMANCE
1967
(OECD standard classification)

	FUNDA-MENTAL RESEARCH	APPLIED RESEARCH	DEVELOP-MENT	TOTAL
a) Million guilders				
Business enterprise ..	335		745	1,080
Government	35		15	50
Non-profit institutions	240		90	330
Higher education	345		55	400
Total	955		905	1,860
b) Percentages				
Business enterprise ..	31		69	100
Government	70		30	100
Non-profit institutions	73		27	100
Higher education	86		14	100
Total	51		49	100

SOURCES: CBS Survey: *Speur-en Ontwikkelingwerk in Nederland 1967* and OECD standard classification.

As may be expected, the share of research is relatively highest in the higher education sector, with 89% of the total in 1969. In non-profit institutions, research amounted to 73% and in goverment agencies to 70% of total R and D expenditure in 1967 and to 73% in 1969.

The relation between research and development is practically reversed in the business enterprise sector, where research accounted for 29% and development to 71% of R and D expenditure.

The Ministry of Education and Sciences estimates for 1971 as shown in Table 14 indicate a similar pattern. As regards overall expenditure on R and D, the relative importance of development is about the same as the share of research.

Table 14. EXPENDITURE ON INTRA-MURAL R AND D BY TYPE OF ACTIVITY AND SECTOR OF PERFORMANCE
Year 1971[1]

	MILLION GUILDERS			% OF TOTAL	
	RESEARCH	DEVELOPMENT	TOTAL	RESEARCH	DEVELOPMENT
Business enterprise .	461	1,129	1,590	29	71
Higher education ...	481	59	540	89	11
Government	53	20	73	73	27
Other institutions[2] ..	343	127	470	73	27
Total	1,338	1,335	2,673	50	50

1. According to 1969 ratios; some institutions are not included.
2. Total or weighted averages of data for non-profit institutions sponsored by the Government.

SOURCE: Ministry of Education and Sciences.

By sector, there are only minor changes in the respective shares of research and development in the "other institutions" sector. The similarity between the 1971 pattern and the breakdown for 1967 is not surprising, as the estimates for 1971 are based on the ratios established in the 1969 survey since there have been no major changes between 1967 and 1969. The higher education sectors show no major changes between the 1964 survey and the 1969 survey.

In comparison with other OECD countries, the Netherlands pattern of expenditure on R and D by type of research closely resembles what can be considered a "continental model" with a relatively large share of fundamental and applied research, as against the "American model" in which the share of both fundamental and applied research accounts only for about a third of overall expenditure on R and D. There seems to be a tendency to enlarge the share of development, in particular in the field of community-oriented types of research performed in government-sponsored non-profit institutions.

4. R AND D EXPENDITURE BY TYPE OF COST

Intra-mural R and D expenditure by type of cost can be analysed for three bench-mark years 1959, 1964 and 1967. In the first statistical survey by the Central Bureau of Statistics labour costs and other current expenditure were lumped together. They accounted for 76% of the overall expenditure on R and D. In the 1964 and the 1967 surveys other current expenditure was given separately from the labour cost. For both 1964 and 1967 it accounted for about a quarter of the total (24%). The labour costs amounted to 52% in 1964 and to 55% in 1967. The share of capital expenditure remained relatively high, with 24% of the total in 1959 and 1964 and 21% in 1967.

The share of current expenditure (labour costs plus other current expenditure) was highest in the business enterprise sector (85% in 1967) followed by the government and non-profit institutions sector (79% in 1967). Conversely, capital expenditure amounted to about a sixth of the total in the business interprise sector and to about a fifth of the total in the government and non-profit institutions sectors.

In all the three bench-mark years, capital expenditure was relatively high in the higher education sector. It fluctuated at about two-fifths of the total, from 37% in 1959 to 43% in 1964 and back again to 37% in 1967. This appears to be linked with the expansion of higher education and the corresponding expansion of education and research facilities in this sector.

Some indications on average expenditure by person employed in R and D can be gathered from the 1964 and 1967 data collected by the Minister of Education and Sciences (Table 16).

These figures must be interpreted with the utmost caution, as a direct comparison of 1964 and 1967 data hardly seems possible. They suggest a trend towards a reduction of differences in expenditure per person in various sectors. It could imply better information and more mobility within the R and D activities. The internal mobility has undoubtedly been enhanced by the extension of relationships between business firms and higher education, reflected in particular in the increase of the number of highly qualified business and industrial experts

Table 15. INTRAMURAL R AND D EXPENDITURE BY TYPE OF COST

	CURRENT EXPENDITURE		CAPITAL EXPENDITURE	TOTAL
	LABOUR COST	OTHER CURRENT EXPENDITURE		
a) Million guilders				
1959				
Business enterprise	283		61	344
Government and non-profit institutions	86		41	127
Higher education	41		24	65
Total	410		126	536
1964				
Business enterprise	376	168	100	644
Government and non-profit institutions	145	61	80	286
Higher education	97	42	107	246
Total	618	271	287	1,176
1967				
Business enterprise	615	300	165	1,080
Government and non-profit institutions	215	85	80	380
Higher education	195	55	150	400
Total	1,025	440	395	1,860
b) Percentages				
1959				
Business enterprise	82		18	100
Government and non-profit institutions	68		32	100
Higher education	63		37	100
Total	76		24	100
1964				
Business enterprise	58	26	16	100
Government and non-profit institutions	51	21	28	100
Higher education	40	17	43	100
Total	52	24	24	100
1967				
Business enterprise	57	28	15	100
Government and non-profit institutions	57	22	21	100
Higher education	49	14	37	100
Total	55	24	21	100

SOURCE: CBS-Survey: Speur-en Ontwikkelingswerk in Nederland 1967.

or specialists acting as "associate part-time professors"* in universities and above all in scientific, medical and engineering faculties. According to one estimate, 262 researchers from the business enterprise sector devoted part of their time to teaching at universities in 1969.

Table 16. EXPENDITURE ON R AND D PERSONNEL EMPLOYED IN R AND D
R AND D EXPENDITURE PER PERSON EMPLOYED IN NATURAL SCIENCES AND ENGINEERING

	EXPENDITURE (MILLION GUILDERS)	PERSONNEL FULL-TIME EQUIVALENTS	EXPENDITURE PER PERSON EMPLOYED (GUILDERS)
Business enterprise			
1964	664	27,280	24.3
1967	1,08[illegible]	29,700	33.0
Higher education			
1964	193.7	5,820	33.3
1967	283.5	8,200	34.6
Other R and D institutions			
1964	1[illegible]8.4	10,400	18.1
1967	[illegible]7.6	12,300	25.4

SOURCE: Ministry of Education and Sciences.

Another aspect of mobility is the "brain-drain" which has been a major concern in some European countries. In order to assess its extent, the Netherlands government in 1967 charged a special committee to investigate the flows of scientific personnel going abroad and coming from abroad.

According to the conclusions of this committee the overall trend was not disquieting as far as sheer numbers are concerned. There may be a qualitative loss in some disciplines but it is largely compensated by the gains in communication and co-operation across national boundaries.

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* Buitengewoon hoogleraar.

It has been a tradition in the Netherlands for young people to complete their higher education by a period of study or stay abroad. Most of them returned after periods, varying in length, spent at foreign universities or in research centres. It has been generally admitted that this practice has been highly beneficial and has allowed the Netherlands scientific effort to be maintained at an international level. Consequently no special measures are necessary for the time being, and it is deemed that the best means to attract brilliant young researchers is to create centres of excellence of high quality and international fame such as, for example, the universally-known centre of astronomy at Westerbork.

Part Two

INSTITUTIONS OF SCIENCE POLICY

I

THE DETERMINATION OF SCIENCE POLICY

1. GENERAL OUTLINE OF THE INSTITUTIONAL FRAMEWORK

According to the provisions of the Constitution of the Netherlands,* the King can do no wrong and the Ministers are individually responsible to Parliament for their activities. These provisions form the basis of the constitutional parliamentary monarchy of the country. The Prime Minister, who chairs the Council of Ministers, is especially charged with co-ordinating the activities of the Ministerial departments and is responsible for general government policy, the coherence of which is assured by the Council of Ministers. State secretaries represent their minister in all cases in which it is deemed necessary. They are responsible to Parliament for that part of the departmental activities with which they are entrusted by their ministers. State secretaries are not members of the Council of Ministers.

For a number of "horizontal" policy areas the Council of Ministers has established standing committees of some of its members, for example, the Committee for Economic Affairs and the Committee for Regional Planning, and, since 1971, the Committee for Science Policy described below.

The Minister without portfolio for Science Policy and University education is charged with the co-ordination of the R and D activities of all ministers.

* The Netherlands, together with Surinam and the Netherlands Antilles, form the Kingdom of the Netherlands. The relations between these countries are based upon the Statute of the Kingdom of the Netherlands, embodying the agreement voluntarily concluded by the partners in 1954. The Statute is the Constitution of the Kingdom. Unless it is otherwise stated, however, the terms "Netherlands" and "Constitution" in this review refer to the state in Europe, and its constitution, which dates back to 1814.

Governmental policy is carried out under the control of Parliament whose co-operation is required in all legislative matters.

The Parliament includes two Chambers: the Second Chamber with 150 members, directly elected, and the First Chamber with 75 members, who are elected by the Provincial Chambers.

In order to improve the efficiency of their procedures both Chambers have established standing committees of their members. Besides the standing committees for each department, there are also others for specialized matters such as nuclear energy. Recently both Chambers have formed standing committees for science policy and university education. Annually either the Second Chamber in pleno or the standing committee concerned holds a special session on the science budget published yearly and on the recommendations of the Science Policy Council regarding this budget.

Thus the development and implementation of science policy are mainly the result of decisions and operations taken and carried out within the Executive branch, as indicated in Chart 2. The importance of governmental activities in this area in fact results from a gradual development dating back to the last century.

The beginnings were similar to those of other countries. In 1808 the Royal Academy of Sciences and Letters was established as the first public organisation in the area of science. For a long time the Academy, subject to regular changes in its organisational structure, remained unique as an advisory body to the Government in this area.

About 1880, when the country was still predominantly agricultural in character, the first move was made towards a science policy directed at helping Dutch agriculture, through instruction, guidance and education based on scientific results. For this purpose the government created regional experimental stations.

The third phase developed towards the end of the first World War (1917) when, aware that scientific research would be indispensable for future progress and economic development, several prominent scientists met together and started a campaign for the creation of an organisation to guide the development of applied scientific research in the interest of future progress in the Netherlands. In 1932, this organisation, the Central Organisation for Applied Scientific Research (TNO), came into being.

Soon after World War II, the Government, aware of its task to stimulate and give guidance to R and D activities in the interest of the reconstruction of the Netherlands economy, gave a new impetus to TNO

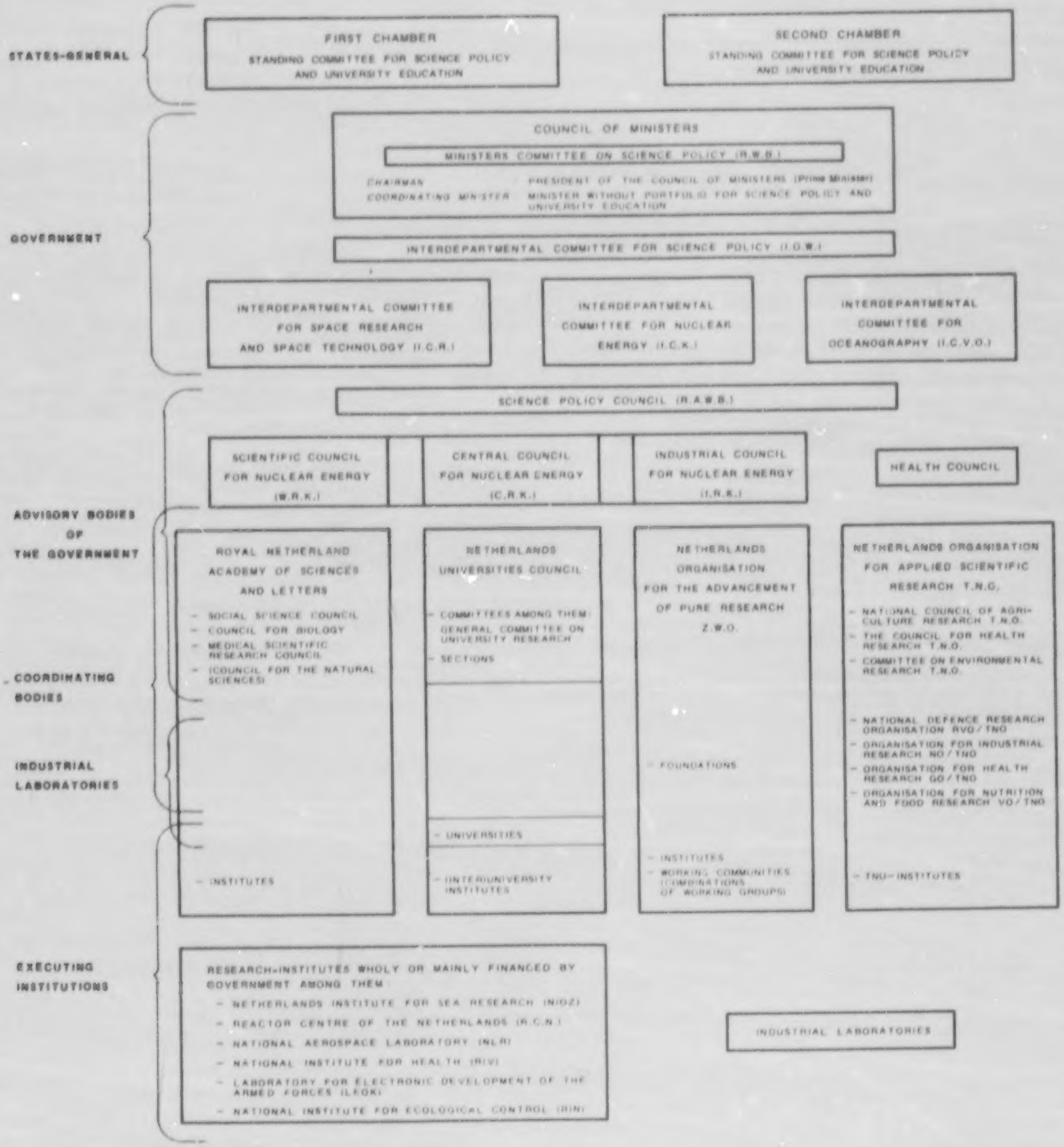
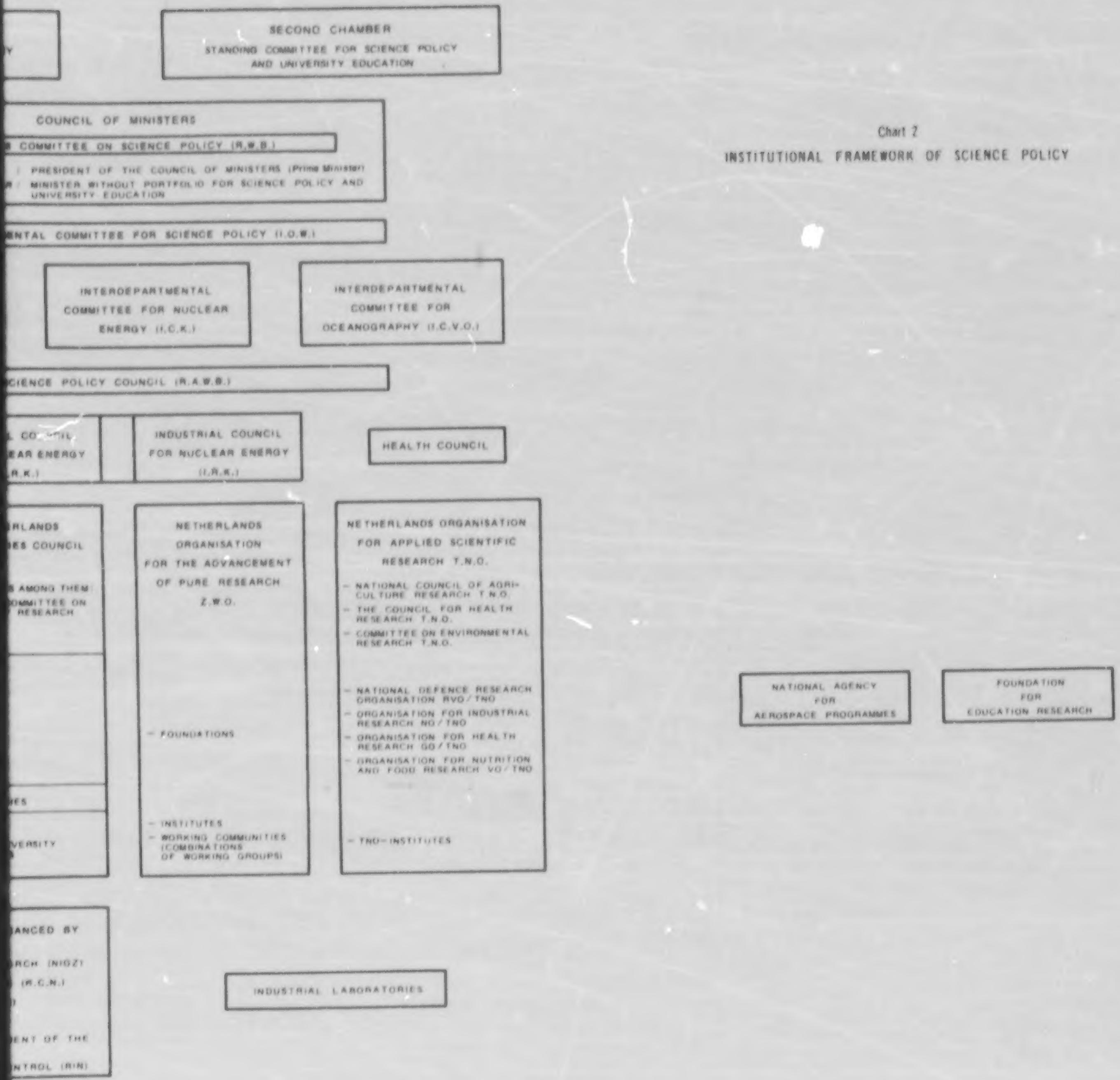

STATES-GENERAL
FIRST CHAMBER
STANDING COMMITTEE FOR SCIENCE POLICY AND UNIVERSITY EDUCATION
SECOND CHAMBER
STANDING COMMITTEE FOR SCIENCE POLICY AND UNIVERSITY EDUCATION
GOVERNMENT
COUNCIL OF MINISTERS
MINISTERS COMMITTEE ON SCIENCE POLICY (R.W.B.)
CHAIRMAN
PRESIDENT OF THE COUNCIL OF MINISTERS (Prime Minister)
COORDINATING MINISTER
MINISTER WITHOUT PORTFOLIO FOR SCIENCE POLICY AND UNIVERSITY EDUCATION
INTERDEPARTMENTAL COMMITTEE FOR SCIENCE POLICY (I.O.W.)
INTERDEPARTMENTAL COMMITTEE FOR SPACE RESEARCH AND SPACE TECHNOLOGY (I.C.R.)
INTERDEPARTMENTAL COMMITTEE FOR NUCLEAR ENERGY (I.C.K.)
INTERDEPARTMENTAL COMMITTEE FOR OCEANOGRAPHY (I.C.V.O.)
ADVISORY BODIES OF THE GOVERNMENT
SCIENCE POLICY COUNCIL (R.A.W.B.)
SCIENTIFIC COUNCIL FOR NUCLEAR ENERGY (W.R.K.)
CENTRAL COUNCIL FOR NUCLEAR ENERGY (C.R.K.)
INDUSTRIAL COUNCIL FOR NUCLEAR ENERGY (I.R.K.)
HEALTH COUNCIL
COORDINATING BODIES
ROYAL NETHERLAND ACADEMY OF SCIENCES AND LETTERS
- SOCIAL SCIENCE COUNCIL
- COUNCIL FOR BIOLOGY
- MEDICAL SCIENTIFIC RESEARCH COUNCIL
- (COUNCIL FOR THE NATURAL SCIENCES)
- INSTITUTES
NETHERLANDS UNIVERSITIES COUNCIL
- COMMITTEES AMONG THEM:
GENERAL COMMITTEE ON UNIVERSITY RESEARCH
- SECTIONS
- UNIVERSITIES
- (INTER)UNIVERSITY INSTITUTES
NETHERLANDS ORGANISATION FOR THE ADVANCEMENT OF PURE RESEARCH Z.W.O.
- FOUNDATIONS
- INSTITUTES
- WORKING COMMUNITIES (COMBINATIONS OF WORKING GROUPS)
NETHERLANDS ORGANISATION FOR APPLIED SCIENTIFIC RESEARCH T.N.O.
- NATIONAL COUNCIL OF AGRICULTURE RESEARCH T.N.O.
- THE COUNCIL FOR HEALTH RESEARCH T.N.O.
- COMMITTEE ON ENVIRONMENTAL RESEARCH T.N.O.
- NATIONAL DEFENCE RESEARCH ORGANISATION RVO/TNO
- ORGANISATION FOR INDUSTRIAL RESEARCH NO/TNO
- ORGANISATION FOR HEALTH RESEARCH GO/TNO
- ORGANISATION FOR NUTRITION AND FOOD RESEARCH VO/TNO
- TNO-INSTITUTES
INDUSTRIAL LABORATORIES
EXECUTING INSTITUTIONS
RESEARCH-INSTITUTES WHOLY OR MAINLY FINANCED BY GOVERNMENT AMONG THEM:
- NETHERLANDS INSTITUTE FOR SEA RESEARCH (NIOZ)
- REACTOR CENTRE OF THE NETHERLANDS (R.C.N.)
- NATIONAL AEROSPACE LABORATORY (NLR)
- NATIONAL INSTITUTE FOR HEALTH (RIV)
- LABORATORY FOR ELECTRONIC DEVELOPMENT OF THE ARMED FORCES (LEOK)
- NATIONAL INSTITUTE FOR ECOLOGICAL CONTROL (RIN)
INDUSTRIAL LABORATORIES

Chart 2

INSTITUTIONAL FRAMEWORK OF SCIENCE POLICY


Y
SECOND CHAMBER
STANDING COMMITTEE FOR SCIENCE POLICY AND UNIVERSITY EDUCATION
COUNCIL OF MINISTERS
S COMMITTEE ON SCIENCE POLICY (R.W.B.)
: PRESIDENT OF THE COUNCIL OF MINISTERS (Prime Minister)
R : MINISTER WITHOUT PORTFOLIO FOR SCIENCE POLICY AND UNIVERSITY EDUCATION
ENTAL COMMITTEE FOR SCIENCE POLICY (I.O.W.)
INTERDEPARTMENTAL COMMITTEE FOR NUCLEAR ENERGY (I.C.K.)
INTERDEPARTMENTAL COMMITTEE FOR OCEANOGRAPHY (I.C.V.O.)
CIENCE POLICY COUNCIL (R.A.W.B.)
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RESEARCH
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VERSITY
NETHERLANDS ORGANISATION FOR THE ADVANCEMENT OF PURE RESEARCH Z.W.O.
– FOUNDATIONS
– INSTITUTES
– WORKING COMMUNITIES (COMBINATIONS OF WORKING GROUPS)
NETHERLANDS ORGANISATION FOR APPLIED SCIENTIFIC RESEARCH T.N.O.
– NATIONAL COUNCIL OF AGRICULTURE RESEARCH T.N.O.
– THE COUNCIL FOR HEALTH RESEARCH T.N.O.
– COMMITTEE ON ENVIRONMENTAL RESEARCH T.N.O.
– NATIONAL DEFENCE RESEARCH ORGANISATION RVO/TNO
– ORGANISATION FOR INDUSTRIAL RESEARCH NO/TNO
– ORGANISATION FOR HEALTH RESEARCH GO/TNO
– ORGANISATION FOR NUTRITION AND FOOD RESEARCH VO/TNO
– TNO-INSTITUTES
NATIONAL AGENCY FOR AEROSPACE PROGRAMMES
FOUNDATION FOR EDUCATION RESEARCH
ANCED BY
RCH (NIOZ)
(R.C.N.)
)
ENT OF THE
NTROL (RIN)
INDUSTRIAL LABORATORIES

and simultaneously established the Netherlands Organisation for the advancement of Pure Research (ZWO), while governmental expenditure on university education and research began to increase spectacularly. At the same time government subsidies for scientific research carried out in private research institutions as well as in industrial laboratories, were considerably increased. Government institutes for scientific research were enlarged and new institutes established.

It was at the beginning of 1963 that the first step in the direction of the formulation of a central national science policy was made. In that year the Government informed Parliament that it was aiming at the promotion of a strong national science policy and international scientific co-operation. As a consequence of this declaration, a working party of high government officials and a group of outstanding scientists started in the winter of 1963-1964 to study the organisational structure for such a policy and delivered its report in September 1964. The existing central scientific organisations were requested to give their advice on the proposals of the working group, in particular the proposal concerning the establishment of a Science Policy Council in the Netherlands.

The Government agreed with the proposal of the working group to create an advisory body to assist it (the Government) in the formulation of its policy with regard to science. In 1965 the Parliament passed a bill establishing the Science Policy Council of the Netherlands. Soon this measure was followed by the creation of an interdepartmental Committee for Science Policy, assisting the Minister of Education and Sciences in his co-ordinative function with regard to science policy.

The appointment in 1971 of a minister without portfolio, specifically charged with the co-ordination of science activities, was a new sign for the growing importance attached by the government to scientific and technological activities in modern economic and social progress.

2. THE EXECUTIVE BODIES

a) The Minister for Science Policy and University Education

One of the most significant institutional innovations brought in by the Cabinet formed in the summer of 1971 is the decision to appoint two ministers in the field of education and science. The first is responsible for the general problems of primary and secondary education, and heads the ministry. The second, without portfolio, is charged with science policy and university education. Also, in the course of the Cabinet period, responsibility for higher vocational training will be transferred to the Minister without portfolio. In connection herewith, it can be pointed out that every time when the law mentions the "Minister for Education and Sciences", this means now that the Minister without portfolio is competent.

The Directorate-General for Sciences was brought under the Minister without portfolio in order to assist him to execute his duties.

The Minister without portfolio is responsible for the establishment of a co-ordinated policy in the area of science. Because of his explicitly mentioned co-ordinating function, his competence cuts through the existing vertically organised departmental structures. This co-ordinating function gives the minister without portfolio a special task with regard to preparing the meeting of the standing committee on science policy of the Council of Ministers. Besides, he is responsible for the co-ordination of the implementation of the decisions taken by the committee. Finally, he has a special responsibility for interdepartmental deliberations on science policy because the chairman and secretary of the Interdepartmental Committee on Science Policy belong to his staff.

The explicit goals are relatively ambitious and show that the new institutions are expected to influence the whole scientific system: "The Government's science policy will be based upon the necessity for setting priorities, not only because of the growing increase in size and cost of scientific research, but also because a balance will have to be established between pure research and research designed to deal more directly with social problems. To achieve these goals, co-ordination and co-operation between universities and between departments will be improved. There will be co-ordination at national level for certain important problems such as scientific research in the fields of environment and regional planning. The setting of priorities with regard to projects for international co-operation will receive renewed attention". *

In the light of these intentions, it is not surprising that the machinery for interdepartmental co-ordination has been somewhat reinforced.

b) Interdepartmental co-ordination of science policy

As has been mentioned before, Ministers are in principle individually responsible to Parliament for the execution of their duties. It follows that they also bear a responsibility for research activities instrumental to their departmental tasks.

Co-ordination of the broad lines of science policy takes place in the Council of Ministers. Major decisions are taken in the Council. In 1969 an Informal Ministers' Committee on Science Policy was set up.

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* Declaration of the new Government to the Second Chamber of the States-General on 4th August, 1971.

Under the chairmanship of the Prime Minister, this Committee has met a number of times to prepare the meetings of the Council of Ministers with regard to science policy decisions and to facilitate interdepartmental co-ordination in this area. The chairman of the science Policy Council and the chairman of the Interdepartmental Committee on Science Policy participated in the deliberations of the Informal Committee.

Since 1971 the Informal Ministers' Committee has been replaced by a standing committee of the Council of Ministers for Science Policy. Such a committee has the task of taking policy decisions which do not require the attention of the Council of Ministers. The collective responsibility of the Council has been safeguarded through the chairmanship of the Prime Minister and through the rule that all conclusions of each meeting of a standing committee should be confirmed by the Council itself. The agenda of the meetings of the standing committee on science policy is drafted in close co-operation between the Prime Minister and the Minister for Science Policy. The secretary of the Committee is the representative of the Prime Minister in the Interdepartmental Committee and by the co-ordination of the Science Policy Division of the Ministry of Education and Sciences, the Vice-secretary is an official of the Ministry of Education and Sciences. The chairman of the Science Policy Council and the chairman of the Interdepartmental Committee attend the meetings of the standing committee.

i) The Interdepartmental Committee on Science Policy

This standing committee was created immediately after the establishment of the Science Policy Council in 1966. It is composed of senior officials appointed by the respective ministries and is presided over by the Director General for Sciences in the Ministry of Education and Sciences.

The Committee meets once a month. Secretariat services are provided by the Co-ordination of Science Policy Division of this Ministry.

The Interdepartmental Committee prepares Cabinet decisions on matters relating to science policy and co-ordinates the implementation of these decisions. It works, in fact, in close contact with the Science Policy Council. In principle, all reports of the SPC are discussed interdepartmentally before Cabinet decisions are taken on them, and, conversely, ministerial consultations with the SPC are first debated within the Interdepartmental Committee.

The preparation of the annual science budget is another function of the Interdepartmental Committee. This document, which is submitted by the Government to Parliament, is not, however, a budget in the usual sense of the word, but at present a compilation, with explanatory notes, of all items for R and D extracted from the budgets of the various Ministries.

The institutional structure for science policy which was based upon the Science Policy Council Act was envisaged as an experimental one. It was expected that after the Council had been in existence for a few years this structure would need to be reviewed and possibly reformed. In the course of the debate in the Second Chamber of Parliament on the science budget for the year 1969, some Members raised the question whether the present co-ordination of science policy was sufficient. During these discussions the Minister stated that he was prepared to ask the Science Policy Council to give its views on the possibilities for improving the present structure in order to optimalize the co-ordination of governmental activities in this field.

In its report the Science Policy Council limited itself to searching for optimalization within the possibilities existing in the present actual constitutional situation, without giving its opinion on the question of whether in this respect alterations are also desirable. Acceptance of this situation meant a. o. acceptance of the responsibility by each minister for the special objectives of their own ministries, in including the scientific research programmes in as far as they directly serve these goals. As it is, each ministry is more or less directly involved in scientific activities.

The responsibility of each minister for the objectives of his own ministry does not allow that efforts for promoting research programmes in the framework of those goals would be transferred to an independent ministry, which would be in charge of the whole complex field of sciences.

Thus, a central ministry where the responsibility for all scientific research programmes would be centralized is incompatible with the Netherlands national political system.

Rejecting the concentration of the whole political responsibility for all scientific research into one ministry, the Science policy council formulated the following recommendations:

- to intensify the informal ministerial deliberations on science policy under the presidency of the Minister President;
- to intensify and extend the activities of the Standing Interdepartmental Committee on Science Policy.

The undesirability of entrusting the entire national science policy to one ministry does not reduce the necessity for one central policy-making authority to survey the whole science activity, to serve as a central source of information and to play a co-ordinating role.

So the Science Policy Council is convinced that for the optimalization of national science policy, it will be necessary to create a special General-Directorate within the Ministry of Education and Sciences, whose task will be the co-ordination of science policy and the support of extra-mural university research in general, as far as this is not incorporated in some other ministry's function.

The Science Policy Council sees two main responsibilities for the member of government (minister, minister without portfolio or sector secretary), who will have to deal with national science policy through a new General-Directorate for Science Policy:

- the political responsibility for a diversified, wide ranging programme of science policy, established and realized in co-ordination with the various ministries;
- the direct political responsibility for a number of scientific agencies and institutes.

ii) The more specialized interdepartmental committees

Mention should be made of the interdepartmental committees, created for fields of science and technology where there is a marked need for government action:

- the Interdepartmental Committee for Nuclear Energy established in 1964 is responsible for the preparation of measures to be taken by the ministers with a view to developing peaceful applications of nuclear energy. It is entirely composed of senior civil servants of departments interested in this field.
- the Interdepartmental Committee for Space Research and Space Technology (1966), is composed of senior civil servants from a number of government departments and agencies. This Committee, under the chairmanship of the Director-General for Sciences in the Ministry of Education and Sciences, advises the Government on the national and international aspects of space research and development. It prepares decisions of the Cabinet in this field and co-ordinates the application of measures resulting from these decisions.
- the Interdepartmental Committee for Oceanography was established recently. It is composed of senior officials from a number of government departments and meets at least once a year under a chairman appointed by the Cabinet. Its tasks is to prepare national policy in the field of oceanography, taking into account the specific responsibility of the individual ministers. The chairman of the Netherlands Commission for Oceanic Research attends the meetings of the Commission. An Executive Committee, composed of a maximum of 7 members, is charged with preparing the decisions of the Commission.

3. THE BODIES WITH A (MAINLY) ADVISORY FUNCTION

In the course of the development of activities dealing with science and technology, the Government of the Netherlands has had to expand its network of advisory bodies (Chart 2) rapidly. In addition to general scientific advice traditionally provided by the Royal Academy, it has had to request expert assistance in such specialized fields as agriculture, nuclear energy and health, or in certain sectors such as the universities and industry. Finally the general formulation of science policy has called for the creation of a council able to provide independent, competent and global advice to the highest echelons of government.

a) The Science Policy Council*

The Science Policy Council of the Netherlands was established in 1966 by Act of Parliament. It is an independent body, acting as the central advisory organ to the government in the field of science policy, and responsible for studying overall problems of national science policy.

At the request of any minister, or on its own initiative, the Council gives advice on the position and growth of R and D, financial implications, relationship to economic growth and other aspects of the impact of science and technology on society. It is the Council's task to make recommendations concerning priorities in the field of science and technology, taking into account the relative position of R and D with regard to the various objectives of government policy.

The Science Policy Council consists of five to nine members appointed by the Government for a term of five years to serve in their personal capacity, although they are drawn from the different university faculties and from industry. The Council's composition is such as to enable it to maintain useful contacts with all national and international institutions and organisations relevant to Netherlands science policy.

The working method of the SPC and its Bureau is determined in large part by its statute, which stipulates that it shall take into consideration the views of other organisations which have a statutory task of advising the Government in scientific matters (the Royal Netherlands Academy of Sciences and Letters, the Scientific Council for Nuclear Affairs and other bodies).

The Bureau of the SPC has been kept relatively small - four graduates, plus administrative personnel. The reason for this modest staff was the view that, given its possibilities for calling on qualified outside expert advice, the SPC itself would not need to be equipped with specialists from all scientific fields. Another consideration was that the Bureau is expected to co-operate closely with different governmental departments and with the Central Bureau of Statistics.

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* Raad van advies voor het wetenschapsbeleid (RAWB).

The SPC meets once a month for a full day. Its channels of communication are:

- formal advisory relations with both the Cabinet as a whole and individual ministers;
- an informal link to the Cabinet, by virtue of the fact that the Council's chairman participates in the discussions of the Cabinet Committee for Science Policy;
- the Secretary and sometimes also the Chairman of the SPC take part in the monthly meetings of the Interdepartmental Committee on Science policy;
- every two months the SPC chairman presides over informal meetings of the chairmen of the central scientific organisations, for the purpose of exchanging information.

At the request of the Government, the SPC has so far delivered reports on the following topics: Space Research and Technology (February 1968, October 1969, September 1971); CERN and the proposed foundation of a National Institute for Nuclear Energy and High-energy Physics (October 1968, July 1969 and January 1971); the financing of projects out of an interdepartmental fund within the annual science budget (December 1969 and regularly thereafter on specific projects); the participation of professional organisations of scientists and others in the formulation of science policy (June 1970); the structure of the Government organisation for science and technology in the Netherlands (October 1970); the financing and organisation of university research (June 1971). Other reports on the methods of government support for industrial research are expected. Most of the reports are published.

The SPC has been requested by the Government to report every year on proposed government R and D expenditure both for the following year and for the four years thereafter. This has resulted in an Interim Report on Government Expenditure on R and D for the period 1969-1971 (March 1968), a sequel to this Interim Report (April 1969), a Progress Report 1970 (February 1970) and a Report on Government Expenditure on R and D for 1971 (May 1970).

In its Interim Report the SPC has attempted to establish a system of "frames of reference": it represents the first attempt in the Netherlands to come to grips systematically at government level with the problems arising from the rapid increase in government R and D expenditure in the past decades, and to arrive at a co-ordinated policy for the allocation of resources (see Part Six, Chapter I).

In the report, the Science Policy Council expressed the view that the diversity of R and D itself and the breadth of its social implications are such that an entirely objective and generally acceptable system of criteria for the formulation of a national science policy is hardly attainable.

It has not proved possible for the Government to accept the general rate of increase suggested by the SPC. Suggestions dealing with the relative rates of growth of various research bodies, however, have been partly taken into account by the budgetary authorities.

The second recommendation suggested the establishment of an R and D fund, a multi-departmental fund within the annual science budget in order to finance advanced projects of a multi-departmental and multi-disciplinary character. The object of such a fund was to give new projects the requisite extra stimulus.

On the basis of more detailed recommendations by the Science Policy Council (December 1969) the Government decided that a separate procedure should be established for each project, based upon common general principles: first, it is up to the Council of Ministers to decide which projects will be financed out of multi-departmental funds; next, direct responsibility for the execution of each project rests with a particular ministry although the projects are financed out of a fund which is on the budget of the Ministry of Education and Sciences; finally, an interdepartmental committee will be established for each project to supervise its development.

The third series of recommendations suggested the inspection of government-financed R and D institutes by special committees of experts so that a critical examination could be made of the nature and efficiency of the work done in government-financed institutes in selected fields of R and D. The results of such an examination were to provide a basis for considering governmental support for the centres involved. In 1970 a committee of experts started to examine the whole field of construction research, which has recently submitted its final report.

At the request of the Minister of Education and Sciences the Science Policy Council has also prepared a report on the participation of professional organisations and others in the formulation of science policy. In this report the Council concludes that in view of the nature of the interests involved, and because of the structure of the organisations of scientists, science policy cannot be considered to belong to those governmental objectives necessitating an advisory organ, completely or partly based upon representation of organisations or institutions involved. The Council holds the opinion that the actual legal structure of the Science Policy Council as a body of scientists appointed by the Crown in their personal capacity, enables its members to take sufficiently into account the general interests, disassociating themselves from particular interests. Moroever, it will be impossible to find a useful and balanced form of representation within a short time, because of the multitude and variety of the existing organisations of scientists. Finally, in the present initial stage of the formulation of a national science policy the Council does not consider it advisable to establish a second advisory body based upon representation as long as the need for such a body has not manifested itself clearly.

The Council believes, however, that it is necessary to maintain relations not only with the central governmental scientific organisations but also with professional organisations of scientists. The participation of these latter organisations in the development of a national science policy will be made possible by the Council through "hearings" and consultations of people interested in particular problems of science policy on which the Council is consulted.

In its most recent report "General Observations on Science Policy at the end of the first period (1966-1971)" the Science Policy Council expressed the view that because science has a strategic position in the present society it is the more necessary to improve the science policy machinery. In a retrospection from 1955 the Council said that from the point of view of policy setting it is important that in the years 1966-1971 the inter-action of science and society was generally acknowledged.

The Council advocated the creation of a Directorate-General for Science Policy within the framework of the Ministry of Education and Sciences. This body should be endowed with sufficient authority and information in order to make it possible that a clear ministerial responsibility for science policy can be borne by the Minister without Portfolio. According to the Council, science policy should be shaped within the Ministry of Education and Sciences and not in an advisory college such as the Science Policy Council.

However, the Council is of the opinion that individual ministers should keep the responsibility for that part of the governmental activities that is directed towards their sectors. Therefore the new Director-General will in the first place get co-ordinative tasks and the care of the research directed towards the developments on the long term.

The Council welcomes the decisions of the Council of Ministers to create a Scientific Council for Government Policy.

b) The Royal Netherlands Academy of Sciences and Letters

The Royal Netherlands Academy of Sciences and Letters* was founded in 1808 and royal charters of 1816 and 1855 have confirmed it as an advisory body to the Government in all matters of scholarly research.

The Academy at present consists of two divisions. That of Sciences, with a maximum of 100 ordinary members (the present number is 82), covers all disciplines from mathematics to medicine, whereas the division of letters unites 80 scholars (at present 71) in the field of law, theology, philosophy, history, letters, economics and sociology. One-third of the members of the Division of Sciences have their main function in industry, government, laboratories, etc. The other members have their main function in the university. As far as the Division of Letters is concerned, most of its members have their main function in the university.

The members of both divisions are chosen by co-optation. They are appointed by the Crown. Each division of the Academy meets separately once a month. The board of each division consists of five honorary members; together they form the Board of the Academy as a whole.

The Academy's seat is in Amsterdam. The office is run by a professional Director and an Assistant Director. The administration of its institutes is centred in the Academy's headquarters. The Academy is financially dependent on the Department of Education and Sciences. It holds in trust a number of endowments and legacies put at its disposal for various purposes.

According to its statutes, the Academy is charged with the task of advising the Government in the field of science and promoting that kind of scientific research which can only be carried out by co-operation between scientists and with the support of the Government. In executing this task the Academy draws the attention of the Government to fields of research in need of development and support, and co-ordinates activities of a multi-disciplinary character.

For this purpose it creates commissions and councils. These bodies consist of Academy members and other experts; in this way the Academy can draw on expert knowledge from a much larger manpower reserve than its statutory limited membership allows. Examples are the Commissions for Oceanic Research for Man and his Environment, for Geophysics and Space Research, for Biophysics and

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* Koninklijke Nederlandse Akademie van Wetenschappen.

Biochemistry, the Councils in the fields of Social Research, Biology and Medical Sciences. The Academy has also brought scientists and government officials together in a special commission for the future of the Friesian Islands and the Wadden Sea.

The Academy has taken the initiative in setting up various research institutes in fields that were not adequately covered by the universities. Mention can be made of the Embryological Institute, the Netherlands Central Institute for Brain Research, the Central Bureau of Mould Cultures, various institutes for ecological studies, situated in regions of ecological or hydrobiological interest, the observation post for seasonal bird migration, and, in the field of the Division of Letters, the Department for Investigation of dialectology, folklore, etc. The Academy runs a national centre for documentation in the field of social studies.

The Academy institutes remain in contact with the universities by providing research facilities for university students, both from the country itself and from abroad. Some of the institute directors have a teaching assignment at one or more universities, either as part-time lecturer or as extraordinary professor.

The Ecological Institute has close ties with the Government Institute for the Conservation of Nature and with various institutes under the Department of Agriculture.

Of the Institutes mentioned above only the Central Bureau of Mould Cultures has regular contact with industry; it provides assistance in the growing of required cultures. It also has a section for medical mycological research.

As far as its international contacts are concerned, the Academy acts as National Member to the International Council of Scientific Unions (ICSU) and to the International Organisation of Medical Sciences. It is a member of the International Union of Academics (IUA).

The Academy acts as the national representative to several International Unions, such as that of Astronomy and of Pure and Applied Physics. It has set up national committees for various interdisciplinary activities of ICSU such as the International Biological Programme and the Upper Mantle Project. It co-operates with academies in other countries in the European Fellowships Programme initiated by the Royal Society (UK) and in setting up a non-governmental international Science Foundation which is to stimulate science and help scientists in developing countries.

The Academy is at present planning:

- to strengthen its structure by appointing at least one professional full-time officer whose main task will be to further internal and external communication, strengthen the organisation of the Academy, keep closer contact with various scientific and advisory bodies, with governmental officials and industrial research institutes and to stimulate and carry out initiatives;
- to gradually expand its network of councils and commissions in order to cover a wider range of disciplines;
- to foster interdisciplinary contacts between individual scientists, working groups, societies, or other bodies, and especially to pioneer into the "no-man's land" between the Arts and the Sciences.

It is generally recognized that the Academy has become much more active in recent years and will probably play an increasing role in the formulation of national research policies.

c) The Netherlands University Council*

The Netherlands Universities Council was instituted in pursuance of Sections 5 to 14 of the University Education Act which came into force on 1st January, 1961 to form a link both between the various Netherlands universities and between these institutions and society at large. The Act specifies as the particular tasks of the Council: firstly, the making of recommendations, on request or on its own initiative, to the Government, the Minister of Education and Science and the universities, and, secondly, the consideration, in their relation to one another, of the plans each university is required to submit once every four years for the required development of education and research. In authorizing the Council to establish committees, the Act emphasizes the importance of research as one of the Council's responsibilities by adding that in any case a committee must be appointed on general questions relating to university research work.

Legislation governing the composition and organisation of the Council was based on this line of thought, as is evident from the provision that the members of the Council shall vote without receiving instructions from or consultation with anyone else. As regards its composition, each of the present 13 universities appoints two members annually, one to represent the Board of Governors and one the Senate, as well as two deputies. In addition, ten members are appointed by the Crown for four-year periods to represent the interest of society at large. Among them are representatives of the principal scientific institutions.

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* Academische Raad.

Including the Chairman, appointed for a four-year period by the Crown on the Council's recommendation, the Council thus has 37 members. An Executive Council consisting of nine Council members is responsible for preparing the ground for the Council's work and for implementing its decisions. As a rule the Council meets five times a year and the Executive Council ten times. The Council has set up nine committees, some for large, interrelated scientific fields and some to deal with wider, more general questions that affect the universities, as well as 40 sections for separate branches of science. In addition, there are ad hoc committees, whose number varies according to requirement. The Council and its organs are assisted by a Bureau, headed by the Secretary of the Council. In the ten years since its establishment, the Council has made a large number of recommendations, on request or on its own initiative, to the Minister and/or the universities. Examples of matters to which much attention has been devoted by the Council, its committees and its groups, are: the re-structuring of university education development plans, division of work among the universities, the problem of the length of courses, educational research. In addition, to assist in moulding opinion on important interuniversity problems the Council has published twelve reports, drawn up by permanent or ad hoc committees.

Despite the wide scope of the Council's tasks, the interplay between the Council and the universities in their execution made the drawbacks of its present structure increasingly clear as academic problems became more complicated. This situation gradually led to the realization that both the organisation of university administration and the closely-related Council structure needed revision.

Matters of importance to future developments have been the passing, in December 1970, of the University Administration (Reform) Act, and a number of changes made in the University Education Act in September 1970. The Government's statutory duty to provide equal development opportunities for State universities and denominational ones to the field of education and research was supplemented by an additional duty when discharging the former, "to make due allowance for a rational division of work between the institutions". The word "rational" is further clarified as meaning a division of work that "can take place without serious detriment to other education and research work" at the university concerned. It was laid down that, before taking any decision on division of work, the Minister should hear what the Council had to say. Another new provision following on the above is that the universities should send their annual estimates to the Council, notably for its opinion on the question of whether approval thereof "would seriously affect in any way the division of work between the institutions".

The changes which the implementation of the "University Administration (Reform) Act, 1970" will entail for the structure of university administration and, consequently, for the structure of the Council, may enhance the importance of the latter's position and function. The growing realization of the necessity for inter-university co-operation and co-ordination had led to initial steps being taken under this Act towards making the Council more representative and promoting its work of co-ordination. The principal change in this respect is the provision that its recommendations will henceforth be issued on behalf of the universities. To that end each university will have one vote in the Council. This provision will oblige members to consult one another in advance, so that they can adopt a standpoint approved by their own university.

The composition of the Council is to be changed as follows: The Council will include three members from each university. The number of members appointed by the Crown is to remain at ten. In addition, the Crown will appoint a vice-chairman as well as a chairman. With 13 institutions as at present, the number of members will be 51. Besides the chairman and vice-chairman, the Executive Council will include one member per university and three "Crown members", i.e. 18 members in all. This will make it easier for the Executive Council to exercise its existing power under certain conditions to make recommendations on behalf of the Council in matters whose handling the Council has not reserved to itself.

Particularly important for the Council's duties in the field of research is co-operation of the sections with the faculties and sub-faculties and the teaching and research units (vakgroepen). These units are to be formed by the faculties and sub-faculties after consultation with the relevant Council's sections. The requirements laid down under the University Administration (Reform) Act for faculties, sub-faculties and teaching and research units offer fresh possibilities for this co-operation. The importance of the Council's sections is also being strengthened in relation to both the Council and the Minister. The new Act contains a provision that the Council shall submit the preliminary recommendations of the sections along with its own recommendations. If the Council itself makes no recommendation, the sections' recommendation is sent, at its request, to the Minister.

As regards the position of the Council in the more distant future, the hope is expressed that, as a result of the amendments included in the Act, and a progressive change in the attitude of the universities, the Council will begin to function, far more markedly than hitherto, as an authoritative co-ordinating body. If the experience gained with this new Universities Council is favourable, then some purpose might be served by granting the Council other, more far-reaching powers.

d) Specialized advisory bodies

Various organisations are explicitly invited to advise the Cabinet on policies in their respective areas of responsibility. In the field of research two important examples are the Organisation for Applied Scientific Research (TNO) and the Netherlands Organisation for the Advancement of Pure Research (ZWO) which will be discussed below.

In addition to such bodies, however, the Netherlands have been led to create several advisory bodies in highly technical areas of prime importance for financial, economic or social reasons such as nuclear energy and public health.

i) The councils for nuclear affairs

Three councils for nuclear affairs were established by the Nuclear Energy Act of 1963: the Central Council for Nuclear Affairs, the Industrial Council for Nuclear Affairs and the Scientific Council for Nuclear Affairs.

The Central Council for Nuclear Affairs gives advice to the Government or individual ministers on general aspects of the national policy in the field of nuclear energy and ionizing radiation. It co-ordinates - if necessary - the activities of the Industrial Council and the Scientific Council as well as those of the Health Council in this field. It is composed of two members of the Health Council, and a representative of TNO, ZWO and the foundation Reactor Centre of the Netherlands. The Ministers of Economic Affairs, of Education and Sciences and of Social Affairs are represented in the meetings of the Council.

The Industrial Council for Nuclear Affairs advises the Government in matters relating to the industrial applications of nuclear energy and ionizing radiation. The Council is not directly concerned with conducting, co-ordinating or financing scientific work, but advises inter alia on stimulating industrial R and D in this field.

Although entitled to give its advice to all ministers, the Council is most closely associated with the Ministry of Economic Affairs, which provides the Secretariat. The Minister for Economic Affairs is represented in the meetings of this Council.

The Scientific Council for Nuclear Affairs advises the Ministers, as well as appropriate governmental and non-governmental institutions on the scientific and technological aspects of matters connected with the application of nuclear energy and ionizing radiation, including education, research and development and co-operation and co-ordination in this field at national and international level. It covers all sciences relevant to nuclear energy and ionizing radiation. The Scientific Council pays, in its advices, attention to the relation between nuclear sciences and other disciplines and to the development of the latter. The five to nine members of the Scientific Council are scientists appointed in a personal capacity.

The Scientific Council for Nuclear Affairs receives, financially, support through the Minister of Education and Sciences.

The task of the Council is not only to judge the scientific and technological merits of projects put forward to it for advice, but also to advise on overall policy in this field.

In a recent recommendation, which was accepted by the government, the Council proposed an overall plan for the Netherlands activities in the field of nuclear physics and high energy physics in the coming ten years, which contains a certain consolidation of these activities.

In this respect the Scientific Council has a position which corresponds with that of the Science Policy Council, although limited to the nuclear area. In drawing up its reports, the council can avail itself of the opinions of other advisory bodies.

The Nuclear Energy Act states that the Health Council advises on health aspects of applications of nuclear energy and ionizing radiation.

In several aspects this system of advising on nuclear energy policy, in which a division of industrial, scientific and health aspects has been built intentionally has functioned satisfactorily. Nevertheless a simplification of this system is being considered.

ii) The councils in the field of public health

The autonomous Health Council, established by Act of Parliament in 1956, advises the minister responsible for public health matters on the situation of scientific medical research in the field of public health. The Health Council is composed of a number of ex-officio members (e.g. the Director-General for Public Health Affairs and all inspectors in this field) and a number of non-official members, appointed by the Crown.

The recently created Council for Health Research, TNO, is a policy organ which deals principally with the organisational aspects of health research, e.g. financing and priority setting. This Council is composed of representatives of the departments concerned and of research institutions in this field.

The Council for Health Research co-operates closely with the Council for Medical Scientific Research of the Royal Academy. Like other councils of the Academy, the Council for Medical Scientific Research, the members of which are scientists appointed "à titre personnel", critically investigates current research and if necessary drafts recommendations to the Government concerning the financial resources to be allocated to particular areas in the field of health research.

II

THE MOST IMPORTANT AUTONOMOUS SCIENCE ORGANISATIONS

In the field of fundamental and applied research two organisations, established by law, play a central role in the promotion and co-ordination of research programmes and activities through funds, almost exclusively made available by the Government.

1. THE PERFORMANCE AND FUNDING OF FUNDAMENTAL RESEARCH: THE ORGANISATION FOR THE ADVANCEMENT OF PURE RESEARCH (ZWO)*

On the recommendation of a preparatory committee, set up immediately after World War II, the Government in 1950 created an organisation comparable with the National Science Foundation in the United States, to promote research devoted exclusively to the extension of knowledge. The Organisation for the Advancement of Pure Research (ZWO) was established by an Act of Parliament (1950) in order to:

- give advice to the Minister of Education and Sciences on the promotion and co-ordination of fundamental research;
- promote fundamental research in every field of science inside and outside universities and co-ordinate such research by all useful means, particularly the distribution of funds.

The managing and advisory bodies of ZWO are composed almost entirely of scientists. This is in accordance with the view of the preparatory committee that the promotion of fundamental research should remain in the hands of scientists themselves.

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* The "Nederlandse Organisatie voor Zuiverwetenschappelijk Onderzoek" (ZWO).

The management of the Organisation rests with a Council, a Board and a Director.

a) The Council

The "Council for Pure Scientific Research", which determines ZWO policy, is composed in such a way that the greatest possible diversity of specialization is represented. Besides one representative from the Minister of Education and Sciences, the Council is composed of one or two representatives from each of the universities, one representative from TNO and five members from outside the academic world while another 5 places are available, if it is deemed desirable, to appoint additional members. These appointments are made by the Minister of Education and Sciences.

b) The Board and the committees

The Board acts according to the directives of the Council and is entrusted with the management of ZWO.

The Board is composed of a president, who at the same time is president of the Council, his deputy (the Vice-president of the Council), one representative of the Minister of Education and Sciences, and five members of the Council, nominated by the Council.

The Board is composed in such a way that a balanced representation of the various scientific disciplines is ensured.

A representative from the Minister of Finance has the right to attend the meetings of Board and Council. The representative of TNO in the Council has a standing invitation to all Board meetings.

The representative of the Minister of Education and Sciences has the right to order suspension of a decision of the Council and the Board. If he makes use of this right the final decision rests with the Minister. So far this right has never been used.

The Board is assisted by five permanent advisory committees - for the humanities, social sciences, medicine, natural sciences and biology. The committees have the task of giving expert advice on research projects for which financial aid is requested. These committees are in practice composed almost entirely of university professors. It must be underlined that this structure avoids a distribution of work along disciplinary lines, and therefore denotes the tendency to avoid setting priorities between fields of science.

The Director, assisted by his staff, prepares the decisions of the Council and the Board and carries them out. He is ex-officio secretary of Council and Board.

c) Funding

ZWO is financed entirely by the Government. Under article 4 of the ZWO Act, a fund was set up into which the Government pays every year a sum covering the budget for that year. Annually the Government determines the size of its grant to ZWO on the basis of the budget proposals of the board of that organisation. For the last few years the fund has only had a reserve of about 2 million guilders. Recently the annual grant of the Government amounted to: 43. 0 million guilders (1968), 50. 2 (1969), 55. 0 (1970) and 63. 6 (1971).

d) The foundations

ZWO is not a performer of research, but finances research undertaken by other bodies. In accordance with this principle, ZWO has developed a system of foundations, created for several branches of science. The most important of these are:

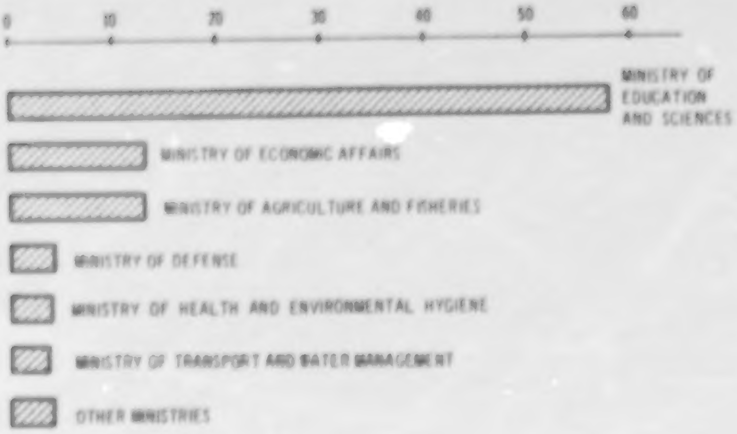
- Foundation for Fundamental Research on Matter (FOM) which is by far the most important: although it is only one item of the ZWO budget, it accounts in fact for more than half ZWO's expenditure and some 40% of the total academic research effort in physics;
- Foundation for Radio-astronomy;
- Foundation for Chemical Research (SON);
- Foundation for Fundamental Medical Research (FUNGO);
- Foundation for Biophysics;
- The Mathematical Centre and Foundation for Biological Research (BION), the most recently established.

These foundations are in fact nuclei of inter-university co-operation, and are specially active in organising exchanges of ideas and information, stimulating co-ordination and promoting certain fields of research. Their management is in the hands of scientists. Each foundation has a number of "communities" for specialized studies in which working groups from the various universities co-operate. The continuous assessment of plans and methods and the regularly-submitted reports serve to foster the efficient use of the funds provided by ZWO and at the same time national co-ordination on a voluntary basis.

Graph 3

GOVERNMENT EXPENDITURE ON R & D BY SOURCE OF FUNDS

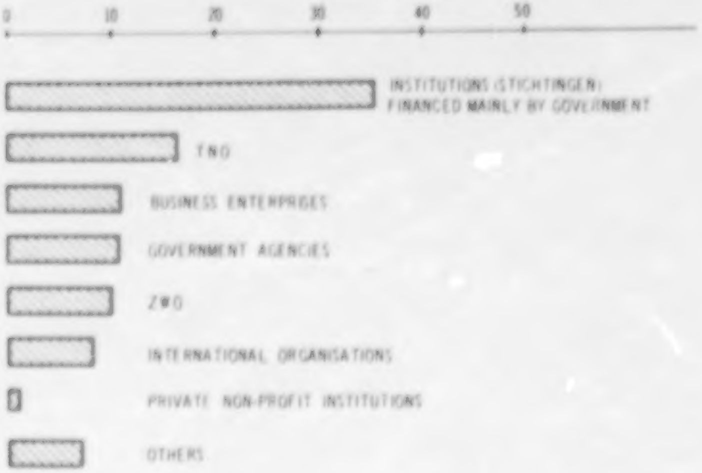
(As percentage of total)
1971 (Budget estimate)



Graph 4

GOVERNMENT EXPENDITURE ON R & D BY "FIRST" DESTINATIONS EXCLUDING HIGHER EDUCATION SECTOR

(As percentage of total)
1971 (Budget estimate)



Source : Wetenschapsbudget 1971.

Since 1964 scientific research of tropics is fostered through a special organisation acting in the same way as ZWO with which it is closely connected.

The growing number of foundations fostered by ZWO has led to certain difficulties. It has not been possible to avoid overlapping of research areas entirely. In addition, the development of the foundations has been more rapid than the growth of funds available to ZWO. Thus the growing claim of the foundations upon ZWO funds has continuously decreased the flexibility of the Organisation and its ability to finance new projects initiated in other institutions.

e) Research grants

Apart from travel grants and fellowships for research abroad, ZWO allocates grants for research in fields not covered by the foundations, or for which they are not well equipped.

Individual research grants represent less than one-tenth of the budget of ZWO, i. e. some 5 to 6 million guilders (Table 17). Applications are reviewed twice a year by the advisory committees and this process is considered extremely useful in identifying new areas where opportunities would require the development of programmes. At present ZWO receives some 350 applications, of which 20-30% are rejected.

The distribution in percentage of these grants between disciplines is shown in Table 18. It did not vary greatly between 1966 and 1970, although there is a slight shift towards the biological and medical sciences at the expense of the humanities and the natural sciences.

f) International co-operation

On several occasions ZWO has played a part in international scientific co-operation. Together with FOM it has been a party to Norwegian-Netherlands co-operation in nuclear energy research and it was involved in the Netherlands part in establishing the European Organisation for Nuclear Research (CERN). It subsidises a number of projects outside the Netherlands on which Dutch scientists are working. ZWO has concluded fellowship agreements with its sister-organisations in France (CNRS), United Kingdom (Royal Society) and Italy (CNR).

g) Project inventories

In 1965 ZWO started the compilation and publication of inventories of research projects. Under the title "Current Research in the

Table 17. ZWO SUBVENTIONS, ACCORDING TO DISCIPLINE

Thousand guilders

	1966	1967	1968	1969	1970
Humanities	1,648	1,927	1,773	1,598	2,252
Social Sciences	1,622	1,441	1,823	2,449	3,250
Physical Sciences	32,148	36,339	41,247	43,964	49,755
Mathematics	2,088	1,581	1,654	1,956	2,599
Physics	20,822	22,488	26,570	27,718	31,957
Chemistry	4,129	6,002	5,678	6,373	7,630
Geology	861	938	1,177	1,380	1,835
Astronomy	4,235	5,285	6,084	6,499	5,734
Life Sciences	4,153	4,964	5,969	7,251	8,842
Biological Sciences	2,262	2,848	3,142	4,086	4,913
Medical Sciences	1,891	2,116	2,827	3,165	3,929
Others	35	18	13	17	21
Total	39,606	44,689	50,825	55,279	64,120

SOURCE: ZWO.

Table 18. ZWO SUBVENTIONS, ACCORDING TO DISCIPLINE

Percentages

	1966	1967	1968	1969	1970
Humanities	4.2	4.3	3.5	2.9	3.5
Social Sciences	4.1	3.2	3.6	4.4	5.1
Physical Sciences	81.1	81.3	81.1	79.5	77.6
Mathematics	5.2	3.5	3.2	3.5	4.1
Physics	52.7	50.4	52.3	50.1	49.8
Chemistry	10.4	13.4	11.2	11.5	11.9
Geology	2.1	2.1	2.3	2.5	2.9
Astronomy	10.7	11.8	12.0	11.7	8.9
Life Sciences	10.5	11.1	11.7	13.1	13.8
Biological Sciences	5.7	6.4	6.2	7.4	7.7
Medical Sciences	4.8	4.7	5.5	5.7	6.1
Others	0.1	0.04	0.03	0.03	0.03
Total	100	100	100	100	100

SOURCE: ZWO.

Netherlands", [illegible] volumes have been printed, in English, covering the humanities, [illegible] physical sciences and the life sciences. A similar volume on the social sciences is published by the Social Science Council of the Royal Academy. The frequency of periodical revisions will be increased in the near future.

2. ORGANISATION FOR APPLIED RESEARCH

The Central Organisation for Applied Scientific Research (TNO) is the dominant body instituted by the Netherlands authorities to promote applied research in such areas as health, nutrition and food, and defence. Within TNO, however, the Organisation for Industrial Research has special importance and calls for a more detailed examination. Finally, mention should be made of the National Aerospace Laboratory and of the Netherlands Agency for Aerospace Programme.

a) The Netherlands Central Organisation for Applied Scientific Research (TNO) *

During World War I, the Royal Academy set up a special committee to answer the question of whether it was not of great urgency to use all the scientific experience available in the Netherlands to search for ways and means that would yield the highest possible return from the few raw materials and production facilities available in the country.

In 1917, the Committee, under the chairmanship of Nobel Prize holder Professor Lorentz, reported to the Goverment that applied scientific research must be the basis for the country's development. To focus attention on the development of this research a kind of a free organisation should be created in which science should lead the way, and for which government should provide the material resources.

A new committee of the Royal Academy, given the task of reporting on the subject to the Ministers of Education, Arts and Sciences and of Internal Affairs and Agriculture, made its report in 1925. Its most important recommendation was, in principle, the same as that of the first committee, but it was much more precise and better defined: one responsible body should direct all activities in the field of applied research. The board of the Organisation should be entrusted with the programming and budgeting of the scientific work. All executive measures were its direct responsibility. **

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* Centrale Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (TNO).

** H. W. Julius: Government-Industry Partnership in Scientific Applications (with special reference to the Netherlands) - Panel on Science and Technology, eighth meeting, 24th January, 1967; United States Government Printing Office, Washington, 1967.

It took 5 years before the Act was presented to Parliament and another 2 years before the Act, creating the Netherlands Central Organisations for Applied Scientific Research, a corporate body known as TNO, became effective on 22nd April, 1932. TNO was given wide scope, namely "to ensure that applied scientific research is put at the service of the community in the most efficient manner possible". In addition, TNO is authorized to advise the Government and the individual ministers in the field of applied scientific research, promote the coherence of the national efforts in this field and foster and support applied scientific research activities and the implementation of the results.

TNO is free to formulate its scientific research programme and may accept sponsored as well as contract research: costs are to be paid by the sponsor(s). TNO can subsidize research done by others. In order to safeguard its independence the Organisation is financially supported by the Government through the Ministry of Finance. The Government contribution to TNO is borne by the Finance Ministry and the Government departments directly concerned with particular activities of the Organisation.

Recognizing the range and diversification of applied scientific research, the TNO Act provides for decentralization and allows for the creation of "special" organisations, each dealing with applied scientific research for a specific range of objectives. These organisations may have their own research institutes, laboratories, etc. General services, such as Mathematics and Statistics, Patents, and a number of committees, come under the Central Organisation.

There are at present four special organisations, corporate bodies like the Central Organisation, with a high degree of autonomy in the formulation of their policy:

- the Organisation for Industrial Research TNO (1935);
- the Organisation for Nutrition and Food Research TNO (1940);
- the National Defence Research Organisation TNO (1946);
- the Organisation for Health Research TNO (1949).

After an unsuccessful attempt to incorporate agricultural research into TNO this sector has retained its own organisational structure under the responsibility of the Ministry of Agriculture and Fisheries. However, co-operation in this field is promoted by the National Council for Agricultural Research, which is a part of TNO as a committee of the Central Organisation.

The Organisation TNO remains, however, the largest, also financially the most important government research institution in the

Netherlands (Graph 4), and the largest of the government research bodies, employing close on 5,000 persons in 1971, of whom more than 20% are qualified scientists and engineers (Table 19).

i) The internal structure

The central board and the board of the special organisations decide on general principles and policies of TNO.

These boards are composed in every case of representatives from the world of science, from the sectors of society served by the central or special organisation and from the government. All members of these boards are appointed by the Crown, upon the recommendation of the ministers concerned. The government representatives are full members of the boards of the special organisations and have a right of veto which has seldom been used.

By their composition the boards should be able to take three important aspects into account: the scientific opportunity, the needs of the sector concerned, and the information the Government needs to formulate its policy.

The Board of the Central Organisation is composed of the chairmen of the Central Organisation and the four special organisations and of representatives from the sectors of society served by TNO. It has an Executive Committee to which the routine management of TNO is entrusted.

Each institute of TNO is supervised by an advisory council composed on the same basis as the boards of the organisation. In all matters relevant to the position and activities of the institute, the advisory council reports to the board of the special organisation to which the institute belongs. It advises its institutes regularly on their research programme and budget. Whilst the board of the organisations weigh up the relative importance of the scientific activities of the institutes, the institutes' councils are by contrast concerned with concrete projects and programmes. Although the institutes' councils have formally an advisory role only, in fact they decide on the work to be done in the following year. In practice, the policy of the Organisation being known, initiatives and proposals are brought forward by institute directors and qualified scientific officers.

ii) The resources

As is illustrated in Table 19, the main source of income of TNO is the annual government subsidy for current expenditure and capital investments. This subsidy amounted in 1971 to almost 140 million guilders, i.e. about 70% of the total budget of TNO. It enables the

Table 19. BUDGET OF THE ORGANISATION TNO*

	1969		1970		1971	
	THOUSAND GUILDERS	%	THOUSAND GUILDERS	%	THOUSAND GUILDERS	%
Government subsidy:						
Exploitation	103,790	60	110,754	60	117,221	60
Capital	20,600	12	21,470	12	22,400	11
Total	124,390	72	132,224	72	139,621	71
Government contracts	13,816	8				
Other contracts and contributions ..	35,527	20	52,500	28	57,400	29
Total receipts	173,733	100	184,724	100	197,021	100
Total personnel of which scienstists and engineers	4,498 persons 797		4,776 persons		4,877 persons	

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* The expenditure figures concern total subsidies. In the science budget only 70% of these figures are considered as R and D expenditure.

SOURCE: TNO.

Organisation to carry out a research programme of its own. Besides the annual grant from the Government, TNO also receives financial support from sponsors, such as industry, governmental institutions and international organisations (e.g. Euratom). The Government share in the total budget of TNO has shown a slight decrease in the last few years, from 75% in 1965 to 71% in 1971.

The Central Organisation submits to the Minister of Finance an annual budget proposal for current expenditure for the next year. The budgets of the special organisations are incorporated in this proposal. Weighing up very generally the needs of the organisation and their relative importance, the Central Organisation decides on the allocation of the government subsidy, after it has been determined by the Minister of Finance, to its own activities and to the four special organisations. Apart from this exploitation subsidy TNO also submits a request to the Minister of Finance for a capital investments subsidy. This is administered by the Central Organisation for TNO.

(ii) The diversification of research activities

The research activities of TNO are carried out in its institutes. The Central Organisation considers that since the scope of TNO is so wide there is no need to create additional institutes for the new social problems mostly of a multi-disciplinary nature - environmental and traffic problems, country planning and similar matters. In its view there would even be a danger in creating special institutes, for this would undoubtedly lead to duplication in personnel and equipment. Both resources are already (at least in some categories) scarce as it is.

For these problems the Organisation TNO therefore opts for permanent or ad hoc co-ordination between groups and institutes already in existing inside or outside the Organisation. To implement this policy, co-ordinating committees have been created in areas such as the unwanted side-effects of pesticides, environmental research, country planning and traffic research. Further, there will probably be in the near future a more centralized priority-setting process in TNO.

Research on behalf of sponsors can be carried out on a confidential - and, as far as research projects of a reasonable size are concerned - exclusive basis. This means that TNO is not always free to accept exclusive new research contracts, because of prior obligations. In the case of contract research, sponsors, as a rule, become exclusive owners of all findings of direct interest to them. For each specific programme agreed upon, after consultation between the sponsor and TNO specialists concerned, cost and time estimates will be given. As TNO is a non-profit research organisation, the normal financial arrangement is payment of actual cost. The basis for estimates and for the calculation of costs charged by TNO is the number of man-hours involved. The cost per man-hour includes all overheads, use of equipment and normal laboratory supplies.

iv) Relations with industry and university

The Industrial Liaison Department of TNO has the task of facilitating contacts between TNO and industry and initiating preliminary discussions. The Organisation for Industrial Research TNO has, of course, very close relations with industry.

The relationship of TNO with the smaller industries is somewhat different from that which it has with the big corporations, since the small industries find it more difficult to fit science into their activities.

Apart from TNO, a specialized government agency - the Netherlands Technical Consulting Service - has obtained excellent results in assisting small firms in this respect. Its advice covers purely financial and managerial aspects, while a technical workshop provides for help in the event of trouble-shooting. With the support of this agency industry is able to implement the results of the TNO research activities more easily.

The ties between TNO and the universities and technological universities are numerous. Professors act as advisers to TNO institutes. Institute directors or university-trained staff members are often employed as extraordinary professors or university lecturers. The concentration of the majority of the TNO institutes in the Delft area, in particular favours good relations with the Technological University at Delft.

b) The Organisation for Industrial Research TNO

The Organisation for Industrial Research TNO is by far the largest of the various specialized organisations of the Central Organisation for Applied Scientific Research TNO. It was established in 1935 to promote the utilization of applied scientific research as efficiently as possible in industry, trade and traffic. To accomplish this it has been led to develop its own research institutes.

The Board of the Organisation for Industrial Research TNO includes representatives of industry, science and government. The Board elects a chairman and a vice-chairman. The day-to-day management is in the hands of the Executive Committee.

The Organisation for Industrial Research TNO comprises 16 institutes. Other institutes are only affiliated to the Organisation.

Finally, the fact must be stressed that many TNO institutes, not attached to the Organisation for Industrial Research have, however, close relations with firms in their respective sectors.

The list of institutes of the Organisation for Industrial Research TNO (see Part Three) shows that the activities of a number of them are directed to specific branches of industry (Metal Research Institute TNO) whilst others are specialized in specific technical fields such as the Central Laboratory TNO and the Central Technical Institute TNO.

Apart from the annual grant to the Industrial Organisation TNO through the Central Organisation TNO, the Government gives additional subsidies to TNO (mainly the Industrial Organisation) in order to promote its co-operation with industry.

On the whole, the growth of the Organisation has been steady in recent years, from 43.5 million guilders in 1965 to 80.1 million guilders in 1971, thanks mainly to government subsidies representing more than half the Organisation's resources in 1971 (Table 20). At present, the Organisation draws about 40% of the resources available to TNO as a whole.

c) National Aerospace Laboratory (NLR) and Netherlands Agency for Aerospace Programmes (NIVR)

The R and D effort in the astronautical and aircraft areas in the Netherlands is carried out essentially in two institutions.

Research in the field of aircraft construction is carried out by the National Aerospace Laboratory (NLR).

The other organisation, the Netherlands Agency for Aerospace Programme (NIVR), plays an important role in aircraft development in the Netherlands.

There is close co-operation between the two organisations as well as between them and technological universities, in particular that of Delft.

These two organisations are described in more detail in Part Three.

In 1969, the budget of the NLR reached approximately 25 million guilders (including interest and write-downs on capital) of which 12.5% were funded by the Ministry of Defence.

The activities of the NIVR include basic and applied research, development and ad hoc investigations in the field of aeronautics, spaceflight and related subjects to support and advise Government and Industry.

Table 20. SOURCES OF INCOME OF THE ORGANISATION FOR INDUSTRIAL RESEARCH TNO

Million guilders

	1965	1966	1967	1968	1969[1]	1970[2]	1971[3]
1. Governmental subsidy (exploitation)	26. 2	31. 1	33. 9	37. 4	40. 8	42. 3	44. 2
of which stimulating subsidies	3. 0	3. 3	3. 7	4. 0	4. 9	5. 2	5. 4
2. Contributions from others ...	3. 7	3. 8	4. 1	4. 4	5. 0	5. 2	5. 4
3. External assignments	11. 2	13. 4	14. 2	17. 8	19. 8	22. 5	26. 2
4. Internal assignments (from TNO institutes)	2. 0	2. 4	2. 7	2. 7	3. 6	3. 2	3. 4
5. Other income	0. 4	0. 4	0. 2	0. 4	0. 5	1. 1	0. 9
Total	43. 5	51. 1	55. 1	62. 7	69. 7	74. 3	80. 1

1. Provisional results.
2. Accepted budget 1970.
3. Draft budget 1971.

d) Research in the service of agriculture

The recent development in agriculture is leading to larger units and to specialization with a consequent decrease in the number of holdings and agricultural workers as well as an increase in size of the holdings, specialization and labour productivity through mechanization and automatization.

Agricultural research is closely related to these developments, which among other things call for a shift towards more fundamental research. For example, advanced research is required for the study of botanical and animal growth and production processes, for economic and sociological research in connection with improved production techniques, for the development of better management techniques for agricultural activities, for the improvement of storage and processing of products, for transportation of products, etc.

Agricultural research in the Netherlands includes agriculture, horticulture and forestry, as well as food and nutrition, handling and processing of produce and nature conservation. In this area there are five categories of research organisations:

- Research institutions under the Ministry of Agriculture and Fisheries;
- Research institutions under the Organisation for Applied Scientific Research TNO;
- Agricultural University in Wageningen;
- Veterinary Faculty of the University of Utrecht;
- Private organisations and industry.

All categories are engaged on fundamental and applied research and on development work, but the universities mainly carry out fundamental research, while the other categories are specially intented for applied research and development.

i) Research institutions under the Ministry of Agriculture and Fisheries

Agricultural institutions under the jurisdiction of the M.nistry of Agriculture and Fisheries are distributed among the following divisions of the Directorate-General of the Ministry:

- Division for Agricultural Research:	22 institutes

- Division for the Development of Agricultural Holdings:	9 experimental stations, many experimental farms and market gardens, etc subsidized by the Government, but managed by private organisations
- State forestry service:	2 institutes
- Service for Land and Water Management:	1 institute
- Veterinary Service:	1 institute
- Plant Protection Service:	1 institute.

Because of the close relationship between development work and extension activities for farmers and market gardeners, the experimental stations, experimental farms, etc. are placed under the division for the Development of Agricultural Holdings. Likewise, the work of the State Forestry Service, the Plant Protection Service, the Veterinary Service and the Service for Land and Water Management is closely tied in with the research programmes of the institutes under these divisions. Up to 1970, all institutes have been more or less free to decide on their own research programmes, internal organisation and outside contacts. Therefore each institute had its own autonomous board of governors and regulations. This form of organisation was of great value in the development stage of the entire agricultural research apparatus. However, to facilitate the co-ordination between institutes and to stipulate better the priorities in research programmes, it was decided in 1970 that most of the institutes should be re-organised. They have been grouped together in a large foundation for agricultural research (The Agricultural Research Organisation) under the chairmanship of the Director-General for Agriculture. Instead of an autonomous board of governors the institutes have advisory committees in which scientific organisations, extension services and farming and industrial organisations are represented.

ii) Organisation for Applied Scientific Research TNO

The purpose of TNO which has already been described, is to promote efficient applied scientific research for the common good. The Organisation for Industrial Research TNO and the Organisation for Nutrition and Food TNO each have two institutes in which research on the processing of agricultural products is carried out. Within TNO however, there is no specific organisation for the exclusive performance of agricultural research. The Organisation has nevertheless a central co-ordinating function with the National Council for Agricultural Research TNO.

The Council, presided over by a chairman appointed by the Minister of Agriculture and Fisheries, is composed of members from the Scientific world (representatives of the institutes of agricultural research and of the Royal Academy), agricultural industry and representatives of the above-mentioned Minister. Many working groups on various subjects have been appointed. The Council has no jurisdiction over laboratories or institutes. Since new regulations came into force in July 1970 the prime mission of the National Council of Agricultural Research TNO has been to provide a liaison and encourage co-operation between important agricultural research organisations.

iii) Universities

There are two universities in the Netherlands directly concerned with agriculture: the Agricultural University at Wageningen, under the Ministry of Agriculture and Fisheries, and the Veterinary Faculty of the University of Utrecht, under the Ministry of Education and Sciences. Their research activities are largely fundamental, mostly in relation to education. In the first university there are approximately 60 scientific departments, while there are around 15 in the Veterinary Faculty.

iv) Co-ordination and programming

In addition to co-ordination by scientists and research managers within the research institutions, there is frequent liaison on research projects and programmes between the institutes through co-ordinating committees and working groups. These ensure the division of work among institutions and discuss research methods and results.

The activities of the Agricultural Research Organisation and the National Council for Agricultural Research TNO in this respect have already been mentioned. Research under the Ministry of Agriculture and Fisheries is primarily programmed by each research institute, but co-ordinated at national level. Most institutes produce a five-year development programme including forecasts for research, manpower and equipment. The institutes also evaluate their current programmes yearly, and, after consultation with their advisory committees, draft a detailed programme for the following year.

Farmers, trade, industries, universities, extension service, and governmental departments are represented on the advisory committees. To harmonize the programmes of the institutes and respect priorities, all current research programmes are on record in a project administration centre. Details of each project are available, such as the aim, the motivation, co-operation activities, duration, expected costs, manpower, etc. Furthermore, the annual project reports include accounts of the costs and time spent as well as the results obtained and the necessary justification for outlays in the coming year.

e) Research in the field of defence

During the period preceding World War II defence R and D was carried out either in Navy and Army institutions or sometimes in industry; in 1953 the Air-Force became a separate service called the "Royal Netherlands Airforce".

This development reflects the Government's constant interest in the progress of research in the aircraft and later in the aerospace fields. As early as World War I the military authorities had recognized the necessity of supporting the national aircraft industry by providing it with intensive technical and scientific assistance. To accomplish this more easily, the Government Service for Aeronautical Research* was created, under the responsibility of the Ministry of War. In 1920 this organisation was transferred to the Ministry of Transport. In 1937 it became the National Aeronautical Laboratory,** in 1961 the scope of its activities was widened to include space-flight technology and the name was accordingly changed to National Aerospace Laboratory.***

After World War II a strong need was felt for intensifying R and D efforts, resulting in the establishment of steering-groups for R and D within the Navy and Army staffs, the splitting-up of the Royal Navy Radio Service into a Laboratory for Electronic Development (LEO) and the Naval Electronic Establishment (MEB), and the re-establishment of the Physics Laboratory as an inter-service institution.

In 1947, by a joint decree of the then Ministers of War and Navy a new corporate body was created under the provisions of the "Act for Applied Scientific Research" of 1930 (TNO). This new body was called National Defence Research Organisation TNO.**** The Physics Laboratory of the Army and the Technological (chemical) Laboratory of the Artillery Arsenal were incorporated in the RVO-TNO.

Shortly afterwards the Naval Laboratory of Electronic Development (LEO) was transformed into an inter-service Laboratory (LEOK), although it remained the responsibility of the Royal Navy.

i) The LEOK and the military establishments

The major military R and D establishment is the LEOK. Its mission includes the development of electronic systems and equipment on behalf of the three services. These also benefit from technical assistance in connection with current or envisaged projects to be allocated to industry. The greater part of LEOK's activities is concerned with radar and radio-communications. The 1970 budget of this laboratory amounted to 3.6 million guilders.

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* Rijksstudiedienst voor de Luchtvaart.

** National Luchtvaart Laboratorium (NLL).

*** National Lucht-en Ruimtevaart Laboratorium (NLR).

**** Rijksverdedigingsorganisatie TNO (RVO-TNO).

The other establishments in this group perform research on a smaller scale, as in the case of the Royal Military Academy (Army and Air-Force) and the Royal Naval College, the Naval Hydrographic Service, the Artillery Experimental Board (CVP) and the Advisory Office of the Corps of Engineers. Their main task is essentially a military one, but part of their activities is to be considered as research.

(ii) The RVO-TNO

The largest of the civilian research institutions is the RVO-TNO, whose principal task is "to ensure that applied scientific research is put at the service of national defence in the most effective manner possible."

The Board of RVO-TNO consists of four civilians and five military members. The chairman and his deputy are chosen from among the civilian members. The military members are high-ranking officers, representing respectively the Minister for Defence, the Royal Army, the Royal Navy, the Royal Air-Force and the Inter-Service Military Medical Council.

In 1970 the yearly subsidy allocated by the Minister of Defence to RVO-TNO amounted to roughly 27.0 million guilders. On a small scale, in cases where this is deemed appropriate, RVO-TNO institutes also accept research orders from civilian bodies. Examples can be found in the fields of human engineering and applied psychology, traffic research environmental hygiene and research on industrial explosive materials. Experience has shown that the specific expertise achieved in research on problems arising from military practice can be of great value in the solution of analogous problems in other areas. About 10% of the research capacity of RVO-TNO is used for non-military purposes.

In 1970 the civilian personnel of the RVO-TNO stood at, approximately, 700, including about 145 graduate scientists. In addition, about 65 scientists are detached to RVO-TNO for the duration of their military service.

Classified in order of magnitude according to the allocation of the funds required for their research programmes, the five research establishments of RVO-TNO are:

- the Physics Laboratory at The Hague, performing operational research and systems evaluation, basic and applied research in solid state physics, infra-red optics, acoustics and electronics used in detection, data-handling, and signal-processing, surveillance, telecommunnication and radiophysics;

- the Medical-Biological Laboratory at Rijswijk, performing basic and applied research in biochemistry, molecular biology, microbiology, toxicology and radiology concerned with the medical aspects of protection against the action of chemical, radiological and biological warfare weapons;
- the Chemical Laboratory at Rijswijk, performing research on defence against chemical warfare agents, environmental hygiene, evaluation and development of protective equipment and devices for detection, identification and decontamination of toxic substances;
- the Technological Laboratory at Rijswijk, performing research and small-scale development in the fields of propellants, pyrotechnics, explosives and ammunition, assistance to the three services in specific armaments problems, research on inherent explosion hazards of industrial products;
- the Institute for Perception at Soesterberg, performing basic and applied research on physiology of the sense organs, perceptual psychology and social engineering in the interests of military and civilian populations.

In addition, RVO-TNO sponsors R and D activities on behalf of the armed forces by contracting out research to civilian research institutes. These contracts may have a continuous or an ad hoc character. They relate inter alia to food and nutrition, mechanical constructions, optical appliances, corrosion and preservation, paints, packaging, metals and other materials, noise problems, etc.

(iii) National and international co-ordination of military research activities

To co-ordinate the national as well as the international relations of the entire defence-research systems in the Netherlands, the Minister of Defence has established the Netherlands Defence Research Co-ordination Committee. This is normally chaired by the chairman of RVO-TNO and is composed of a representative of the Minister for Foreign Affairs and of the same four officers who represent the Minister of Defence and the three services on the board of RVO-TNO.

f) Research in the area of health and environmental hygiene

With growing public concern over the deterioration of the environment, a new dimension has recently been added to the development of medical research since the Second World War. In the Netherlands environmental research has become one of the dimensions of health research, as evidenced by the creation in 1971 of a Ministry of Health and Environment.

i) Research directed towards the improvement of public health

The general responsibility for R and D in the field of public health falls on the Ministry of Public Health and Environmental Hygiene, which can rely in this area on the advice of the Council for Health Research TNO and of the Council for Medical Research of the Royal Academy already mentioned above.

R and D in public health is also partly performed within the Ministry's own installations facilities. The most important of these is the National Institute of Public Health which is specially active in the development of vaccines, pharmacology, bacteriology.

Two other internal institutes, the National Drugs Control Institute and the National Institute of Water Supply should also be mentioned in connection with these intramural research activities.

More than half government-financed health research is, however, performed outside the Ministry, whose resources are allocated to the relevant TNO organisations, namely the Health Research Organisation TNO and the Organisation for Nutrition and Food Research TNO. These two organisations include a number of specialized institutes enjoying a great deal of autonomy. The Ministry is represented on the relevant boards.

Some grants are allocated by both the Ministry and the TNO organisation for special research projects carried out outside their institutes. However, the growing need for health research in universities and university hospitals has been met by the Foundation for Fundamental Research (FUNGO) within ZWO which funds and co-ordinates health-oriented academic research projects.

It is hoped that the Royal Academy's Council for Medical Research will present recommendations for improving the system in the field of medical research in order to enable the Ministry to develop a short-term and long-term strategy, to be implemented in collaboration with the TNO and ZWO organisations and industry.

Finally, one important ingredient in this re-appraisal of the health research system in the Netherlands should be the promotion of contacts with industry. Such contacts already exist in all institutions but are not systematic and are not generally considered to take full advantage of all opportunities.

ii) Research directed towards the improvement of environmental hygiene

Health research comprises many aspects of environmental hygiene connected with the biological and physical environment of the human being. Medical research is also concerned with the various aspects of environmental dangers for the human constitution.

Environmental hygiene is the responsibility of various ministries, which promote research activities concerning air and water pollution, water supply, purification of effluent water, soil pollution and the disturbance of the psychic balance through inadequate work and leisure conditions. The co-ordination of these activities is the responsibility of the Ministry of Health and Environment created in 1971 which gives direct strategic guidance to the bulk of the health-related environmental programmes.

With about 4 million guilders, the State Institute for Public Health performs a significant share of the research programme of the Ministry in the field of environmental research.

In the field of food hygiene, the Food and Nutrition Organisation TNO is active, with a budget of about 15 million guilders. The central Institution for Food Research is the largest institute within this Organisation. Two million out of its budget of ten million guilders are allocated to environmental research. The TNO Institute for public health engineering, whose budget reached 6.7 million guilders in 1971, carries out research on air pollution components, noise, technical improvements in living conditions, etc.

Environmental research is also carried out by the National Defence Organisation TNO. In its chemical laboratory, medico-biological laboratory and technological laboratory about 6 million guilders are spent yearly on this type of research.

It is estimated that more than 60 million guilders a year are used at present by the Government, for environmental research activities.

In order to co-ordinate national activities in the field of environmental research, the Central Organisation TNO has recently established a special commission under the presidency of the deputy-chairman of the Central Organisation. Its membership consists of high officials of the various ministries concerned with this activity and representatives of the universities and industry.

Finally, it can be pointed out that the fact that the Ministry of Health and Environment has taken the initiative to establish a long-term functional research programme in the field of health and related aspects of human environment enhances the prospects for a coherent, co-ordinated approach to environmental problems through the development of multi-disciplinary integrated research efforts.

CONCLUSION

The description of the mechanisms which the Netherlands have developed in order to formulate and implement science policy could easily give the impression of a highly centralized system, where one minister determines major orientations, and one committee co-ordinates the application of these decisions by a handful of institutions directly under ministerial control. Nothing could be further from reality. It is true, however, that no institutional description answers the degree of decentralization within the administration, nor the intensity of contacts between decision-makers in all types of institutions in the Netherlands.

In effect, these decision-makers form a community sufficiently limited in size for the members to know each other well, to be relatively well-informed about each others problems and opinions and, above all, to have permanent and easy access to one another. It is not surprising therefore, that "administration by committees" is a systematic practice. For example, there is hardly a scientific institution which does not include one general board to preside over the elaboration of its budget and at least one other panel to ensure working contact with the relevant political, economic, scientific or social sectors. Since this pattern is repeated at all levels of government, interlocking committees constitute a veritable pyramid whose summit could be represented by the Council of Ministers, the Sub-committee for science policy and the Inter-departmental Committee for Science Policy. What is more, this pyramid represents only the bodies which have acquired a sufficiently permanent membership and area of responsibility to justify explicit and formal institutionalization. Many others are made or unmade daily, as problems arise; a few colleagues may attend one or two meetings to define and discuss common preoccupations, and if need be to eliminate differences.

The advantages of this type of flexibility and informality are very obvious if one compares the administrative practice in the Netherlands with that of other countries where excessive bulk or formality create administrative bottlenecks blocking the flow of ideas and information. In fact it is unquestionable that this system has enabled the administration of the Netherlands to identify new problems rapidly and take advantage of the decentralized structures to develop original responses in the political, social or economic interest of the country.

According to some observers there is, however, a negative side to this picture as well. Many critics admit that the present system encourages "concertation" among decision-makers, but argue that this "concertation" very often leads to a blurring of the key issues, evading potential sources of tension and, above all, shunning open discussion of controversial subjects. Evidence of this is supposed to be the difficulty of assigning definite responsibilities in the administration for any single national programme, or the difficulty of altering the basic orientations of existing institutions.

In other words, policies dealing with areas such as industrial activity, quality of life or education would tend to favour existing institutions and practices rather than promote the development of new ones.

This is, the case, to a large extent, in all societies where past successes often stand in the way of new ones. It is, however, the central mission of science policy to identify dangers and opportunities, and, by so doing, to suggest a smoother transition to a more balanced future.

Part Three

PROSPERITY THROUGH RESEARCH

I

ECONOMIC GROWTH AND STRUCTURAL POLICIES

The basic feature of the Netherlands is an adaptable economy. Hampered by the scarcity of available land and physical resources, it is fundamentally exchange-oriented, open to external influences and fully exposed to international competition. The global value of imports of goods and services amounts to about 50% of the gross national product. As a rule, the deficit in the trade of goods is balanced by a surplus on services and factor income from abroad.

The Netherlands has a long tradition as a trading nation. Its geographical situation makes it a natural cross-roads of both land and sea trade routes. Transport, commerce, banking and transit have become major occupations.

Since the end of the 19th century, and particularly during the last few decades, the Dutch have developed a highly efficient agricultural system. Not only is the yield per acre among the highest in the world but new methods of market-gardening and food-processing are about to transform the very basis of agricultural production and change it into a continuous process of food production along industrial lines.

Between the two world wars and, in a greater degree, after the Second World War, the primary concern was to concentrate on industry. New branches of manufacturing were created more in consideration of the needs and tendencies of world markets than in view of domestic outlets. This led to a particular pattern of industrial development: the rise of a number of big corporations of multi-national character and conscious specialization in research-intensive industries based on continuous promotion of new technologies. Consequently the relationship between science, research and economy is looked upon as a basic condition for future progress. The objective of social welfare is becoming increasingly important, however cultural aspects are yet absent.

1. GROWTH OF PRODUCTION AND PRODUCTIVITY OF LABOUR

In a long-term perspective the Netherlands economy experienced sustained growth both during the 1950's and 1960's. In real terms the gross national product expanded at an average annual rate of 4.9% in the period 1953-1968. This rate of growth has been faster than that of the total OECD area and also slightly superior to the average figure for the European OECD countries. The pace of expansion accelerated in the 1960's and rose to 5.8% per year between 1963 and 1968, which compared still more favourably with the average of European OECD countries.

Table 21. GROWTH OF PRODUCTION AND LABOUR PRODUCTIVITY

Average annual growth rates 1955/1968 and 1963/1968

	GROSS NATIONAL PRODUCT	MANU-FACTURING	LABOUR PRODUCTIV-ITY TOTAL ECONOMY	LABOUR PRODUCTIV-ITY MANU-FACTURING
Netherlands				
1953/1968	4.9	6.6	3.9	5.5
1963/1968	5.8	6.7	5.1	6.9
Total OECD countries				
1953/1968	4.3	5.1	3.2	3.4
1963/1968	5.3	6.3	4.3	5.0
European OECD countries				
1953/1968	4.7	5.6	4.0	4.0
1963/1968	4.3	4.8	4.3	4.8

SOURCE: OECD.

This good performance can be attributed to substantial increases in productivity, in particular in the agricultural and manufacturing sectors. During the whole period 1953-1968, the productivity of labour in the total economy rose by 3.9% per annum, roughly in line with the productivity advance in the whole area of European OECD countries. In the manufacturing sector, however, productivity of labour increased at an average rate of 5.5% per annum, exceeding by a fair margin the corresponding figures for both the total OECD area and all the European OECD countries together.

The average annual growth rates by major areas of production show that the most dynamic sectors have been manufacturing, construction and services, whereas agriculture, forestry and fishing have lagged far behind. The basic tendency is expected to continue in the next few years according to the projections made by the Netherlands Office of Planning for the years 1969-1973.

As regards productivity of labour, the picture is different. Major increases have been registered in the agricultural sector and in manufacturing. In construction, and especially in services, the average growth rates have been relatively small. These developments are not peculiar to the Netherlands and are consistent with the general trends observed in all industrialized countries.

Comparison of production growth rates and productivity of labour by sector suggests that demand for additional manpower has been and will continue to be particularly strong in services and construction. In manufacturing, the growth of production will henceforth be attributable mostly to gains in productivity; so no substantial increase in employment can be expected in this sector.

Table 22. GROWTH OF PRODUCTION AND LABOUR PRODUCTIVITY BY INDUSTRY OF ORIGIN
Average annual growth rates 1953-1963, 1963-1968 and projections 1969-1973

	PRODUCTION			LABOUR PRODUCTIVITY		
	1953/63	1963/68	1969/73	1953/63	1963/68	1969/73
Agriculture, forestry and fishing	2.5	2.5	2.0	6.0	6.0	5.0
Industry (excluding construction)	6.0	7.5	8.0	4.5	8.0	7.5
Construction	4.0	8.0	3.0	1.5	6.0	1.0
Services	4.5	4.5	4.0	2.5	2.5	2.0
Business firms	4.7	6.0	5.0	3.7	5.5	4.0

SOURCE: Netherlands Office of Planning.

The medium-term projections (1969-1973) of the Netherlands Office of Planning show that a further decline in the number of persons employed in agriculture, forestry and fishing is anticipated, with some increase in employment in manufacturing and a substantial need for additional manpower in services and construction.

2. GROWTH PERFORMANCE OF MANUFACTURING INDUSTRIES

These long-term tendencies are responsible for a gradual change in the overall structure of the gross domestic product. As is shown in Table 23 the share of agriculture, forestry and fishing dropped from 12.4% in 1953 to 10.5% in 1960 and to 7.2% of the gross domestic product at current prices in 1968.

During the same period the relative importance of industrial production in the broad sense (including manufacturing, mining and quarrying, public utilities and construction) remained between 41 and 43% of the total. This sector is particularly liable to short-term fluctuations, the result of shifts in demand and supply of goods in home and foreign markets.

The share of all other activities - generally lumped together under the heading of services - showed a fairly steady upward trend. It rose from 46% in 1953 to about 47% in 1960 and to 50.6% in 1968.

Table 22. GROSS DOMESTIC PRODUCT AT FACTOR COST
BY INDUSTRY OF ORIGIN
(As percentage of total)
Bench-mark years 1953-1968

	AGRICULTURE FORESTRY FISHING	MANUFACTURING, MINING AND QUARRYING, ELECTRICITY, GAS AND WATER, CONSTRUCTION	SERVICES
1953	12.4	41.6	46.0
1955	11.4	41.1	47.5
1960	10.5	42.6	46.9
1965	8.4	41.3	50.3
1968	7.2	42.2	50.6

SOURCE: OECD: National Accounts of OECD countries.

According to the medium-term projections of the Netherlands Office of Planning it is expected that agriculture's share will continue to diminish while industry's share is expected to expand somewhat faster than in the recent past. In the service sector, trade, banking, health and educational services as well as public administration will continue to lead. Particular attention will have to be paid to international movements of services as the export surplus on this account is of major importance to the Netherlands economy.

As has been shown in Table 22 the highest gains in labour productivity have been realized in the manufacturing sector. Given its relative contribution to the gross national product, it may be considered as the main pace-setter of economic growth.

Table 24 gives the breakdown by industry on the basis of value added by branch in the years 1965 and 1967. As a percentage of total, food, drink and tobacco comes first with more than 21% in 1967. The major importance of this branch is one of the most peculiar features of the Netherlands industry. It may be explained by the endeavour to process and export the country's agricultural products in the most favourable conditions.

A group of industries, including chemicals, oil refining and extraction ranks second with 15.4%. It is followed by metal products and machinery with 13.2%. Another important branch is the electrotechnical industry with 10.6%. Transport equipment comes next with about 8%.

The first five branches account for more than two-thirds of the total value added in manufacturing. When the food, drink and tobacco industry is excepted, it appears that the four major branches can also be identified, though very roughly, as the most research-intensive ones. Together, these four industries account for almost half the value added in manufacturing.

The Netherlands statistical classification of industrial production indices is limited to a relatively small number of industrial groups so that a detailed comparison of relative growth performance of individual branches is scarcely possible.

If relative growth performance is measured in terms of total industrial production, four groups can be considered as rapidly expanding industries on the basis of average annual growth rates for 1963-1970: chemicals, public utilities, mining, including the rapid growing branch of natural gas extraction, and oil refining.

Table 24. MANUFACTURING - VALUE ADDED BY BRANCH OF INDUSTRY
1965 and 1967

	MILLION GUILDERS		AS % OF TOTAL	
	1965	1967	1965	1967
Food, drink and tobacco	4,177	5,019	20.3	21.3
Chemicals, oil refining and extraction	3,162	3,627	15.4	15.4
Metal products and machinery	2,713	3,120	13.3	13.2
Electro-technical industry	2,422	2,493	11.9	10.6
Transport equipment ..	1,532	1,870	7.4	7.9
Printing and publishing .	1,027	1,228	5.0	5.2
Stone, clay and glass ..	837	992	4.1	4.2
Textiles	949	987	4.6	4.2
Clothing and footwear ..	934	981	4.5	4.1
Metal production	762	829	3.6	3.5
Wood, cork and furniture	667	774	3.2	3.3
Paper	609	674	3.0	2.9
Leather and rubber products	279	315	1.4	1.3
Other manufacturing ...	615	683	3.1	2.9
Total manufacturing ...	20,585	23,592	100.0	100.0

SOURCE: Based on data of the Netherlands Office of Statistics: National Accounts 1969.

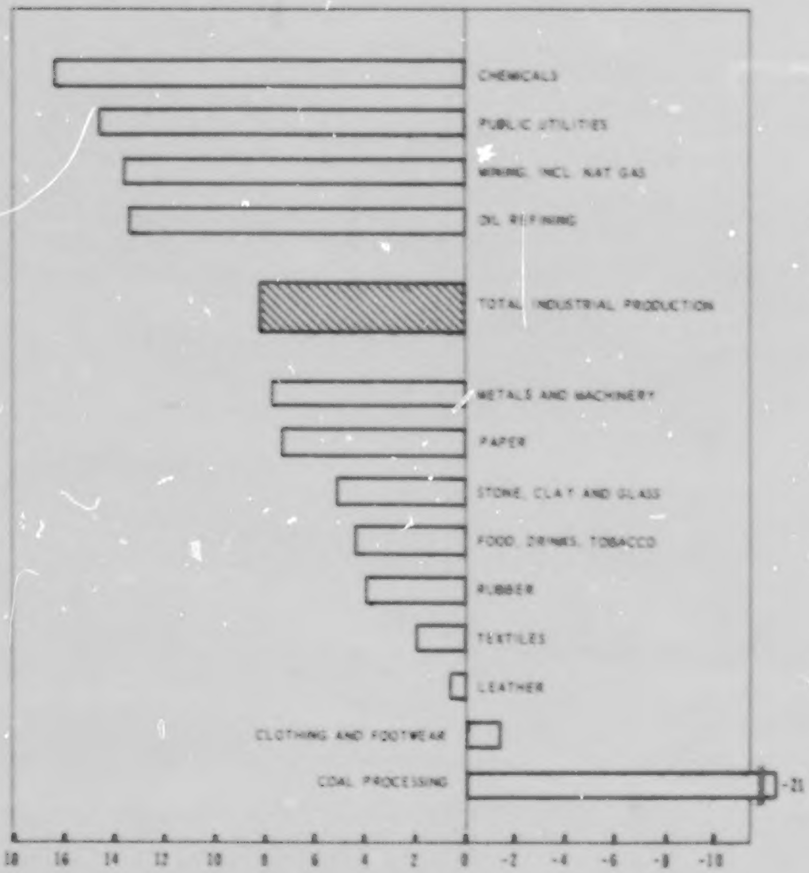
Metal products and machinery as well as paper are close to the average rate of growth in total industry.

In respect to the growth rate in total industry, several branches may be considered as retarding growth rate industries; examples are

Graph 5

GROWTH RATES OF INDUSTRIAL PRODUCTION

Average annual growth rates 1963-1970



Source: OECD on the basis of Dutch national classification and statistics building materials (stone, clay and glass), food, drink and tobacco industries and rubber.

Textiles and leather can be designated as stagnating industries, while clothing and footwear show a declining growth rate. Coal processing is a rapidly declining sector, but this is due to a voluntary policy of re-structuring the pattern of energy resources in the country and gradually closing down coal-mines.

As a result of increasing international competition certain particularly exposed industries lose ground and have to be replaced by other activities. To facilitate the adjustment process in a country like the Netherlands, particular attention is to be paid to new opportunities offering a prospect of rapid growth whilst remaining highly flexible. R and D activities can play a major role in the choice of suitable technologies and the planning of industrial policy.

3. SHIFT TO STRUCTURAL POLICIES

a) Concentration of economic activities

This is largely recognized both in government and industry. However, the industrial policy in general has to deal not only with problems of structural adjustments but of decentralization and regional re-deployment of economic activities.

There is, in fact, a strong concentration of the population in the Western part of the country, in the provinces of North and South Holland and Utrecht, where half the total population lives in a quarter of the national territory. This high degree of concentration is illustrated by the breakdown of production by main regions (Table 25).

Thus there is a strong concentration of all activities, particularly of services in the West. In relation to the breakdown of the gross domestic product, the South occupies an important position in industry, where it ranks second after the West. Agriculture plays a preponderant role in the North and East, though this latter region is also a traditional centre of textile, paper, clothing and footwear industries.

b) Structure of firms in the manufacturing industry

An interesting feature of the structure of Netherlands industrial firms is its polarization with the great majority of small and medium-sized firms on one side and a small percentage of very big ones on the other.

Table 25. BREAKDOWN OF PRODUCTION BY REGIONS
1968
(As percentage of total)
Netherlands = 100

	WEST	SOUTH	EAST	NORTH	NETHERLANDS
Total gross domestic product	55	19	16	10	100
Of which:					
- agriculture, forestry and fishing	45	17	22	16	100
- industry	49	23	16	12	100
- services	63	15	14	8	100
- government	55	18	17	10	100

SOURCE: Central Office of Planning: The Netherlands Economy in 1973.

According to the figures for several bench-mark years, small firms (10-50 employees) account for more than two-thirds of the total (68% and the end of 1968), and medium-sized ones (50-100 employees) for almost 30%.

Only 3% of the total number of firms can be considered as belonging to the category of large societies. However, this category accounted, at the end of 1968, for 57% of total industrial sales and for 51% of the total number of industrial employees.

The ratio of concentration increased between 1953 and 1968, particularly at the expense of the medium-sized firms. Since 1968 the situation has been changing rapidly due to an important increase in the number of mergers, both with Netherlands firms and with foreign enterprises. This movement of concentration is liable to continue in the near future as the Government is of the opinion that Netherlands firms should be able to strengthen their technological, economic and financial basis to face the best conditions possible for international competition.

The increase in the number of mergers with foreign companies tends to stress the international character of Netherlands industry. On one hand, these arrangements lead to greater foreign influence on the home industry. On the other, big Netherlands corporations take over foreign firms

Table 26. PATTERN OF INDUSTRIAL PRODUCTION BY SIZE OF FIRMS

(As percentage of total)

YEAR	SMALL FIRMS			MEDIUM-SIZED FIRMS			LARGE FIRMS		
	NUMBER OF FIRMS	NUMBER OF EMPLOYEES	SALES	NUMBER OF FIRMS	NUMBER OF EMPLOYEES	SALES	NUMBER OF FIRMS	NUMBER OF EMPLOYEES	SALES
1953	69	16	n.a.	28	39	n.a.	3	45	n.a.
end 1964..	67	14	13	30	36	34	3	51	53
end 1966..	68	14	12	29	35	33	3	51	55
end 1968..	68	14	12	29	35	31	3	51	57

SOURCE: Ministry of Economic Affairs.

and improve their relative position on foreign markets. Futhermore, the Netherlands plays an important role as an investor in foreign industry and its investments traditionally exceed the entries from abroad. As an example it is generally assumed that the Netherlands invests more in the United States than the other way round.

c) Importance of foreign markets

The Netherlands is one of the most import - and export - intensive countries in the world. Foreign markets are of utmost importance to Netherlands industry, as more than 36% (1969 figure) of its total sales go abroad.

As is shown in Table 27, foreign outlets are more important to several major industries than the domestic market. The electro-technical industry has the highest export rate, with more than 66% of its total sales. Transportation equipment ranks second, with about 55%. Chemicals, oil refining and extraction industries export approximately half their total sales. Two other branches sell almost half their production to foreign countries: the textile industry (47.5%) and metals, metal products and machinery industries (46.7%).

Three industries export about a third of their total sales: these are engineering, leather and rubber products, paper.

Compared with other industrialized companies, the food, drink and tobacco industries have a relatively high export rate, with a quarter of total sales. The other branches, such as clothing, building materials, wood and furniture, printing and publishing work mainly for the home market and they export from about a sixth to a tenth of their total sales.

d) Main trends in structural policies

In recent years there has been a gradual shift in the economic policy of the Netherlands Government from a broad measure aiming at the creation of a favourable climate for entrepreneurship to a more active policy aimed at promoting structural changes in industry. This policy has three main aspects which are nevertheless closely interrelated.

1. Functional policy - this approach aims at strenghthening the industrial structure as a whole in its functional developments as well as in the introduction of new types of production and economic organisation. A broad array of instruments of a general nature have been defined for this task:

Table 27. EXPORT RATES OF SELECTED MANUFACTURING INDUSTRIES

1969

	1	2	2/1
	TOTAL SALES	EXPORTS	EXPORTS AS % OF TOTAL SALES
	(MILLION GUILDERS)		
Electro-technical industry	5,590	3,702	66.1
Transportation equipment	2,081	1,151	55.3
Chemicals, oil refining and extraction	11,567	5,808	50.2
Textiles	4,433	2,104	47.5
Metals, metal products and machinery	21,231	9,936	46.7
Engineering industry...	4,531	1,502	33.1
Leather and rubber products	1,413	467	33.1
Paper	2,177	663	30.5
Food, drink and tobacco	20,841	5,222	25.0
Clothing	2,034	327	16.1
Stone, clay and glass ..	2,250	348	15.4
Wood, cork and furniture	1,923	117	9.2
Printing and publishing	1,965	177	9.0
Total	71,841	25,930	36.2

SOURCE: Central Bureau of Statistics.

- information in the widest sense, improvement of the social climate, stimulation of productivity, concentration and strengthening of competitive power of firms, selective fiscal policy, encouragement of training and schooling and - last but not least - stimulation of research and development.

2. Regional policy - this aspect has to be viewed in the framework of regional planning which has been developed as a major activity in the Netherlands. Its main task is to realize a statisfactory pattern of employment opportunities in all regions and to re-allocate resources in order to secure a more balanced distribution of income.

3. Sectoral policy - this aspect aims at helping specific industrial branches to improve their technological and economic structure and to enhance their competitiveness.

The Government endeavours in particular with regard to sectoral policy:

- to assist the business community to get a better insight into possible future developments: this is done through medium-term forecasts drawn up by the Central Office of Planning, through structural and sectoral studies, etc;
- to provide assistance in the realization of plans aiming at a structural re-organisation, either by applying regional or functional governmental measures or, in a limited number of cases, by granting support to specific sectors.

II

RESEARCH AS A TOOL OF COMPETITIVENESS

1. SELF-FINANCING OF R AND D

The data published by the Netherlands Office of Statistics within the framework of the international survey of resources devoted to R and D in 1967 by the OECD were obtained by a brief survey covering about 80% of total R and D expenditure and manpower in the business enterprise sector. Estimates were made for the whole sector based on these findings.

According to the overall estimate for 1967 the total national expenditure on R and D amounted to 1,860 million guilders. It was estimated that R and D in the business enterprise sector amounted to 1,080 million guilders, that is, about 58% of total national expenditure.

As shown in Table 28, Netherlands industry is practically self-financing as regards its R and D efforts. It performs approximately as much as it finances, and transfers to and from other sectors are extremely small. In this respect the Netherlands differs from countries like the United States, the United Kingdom and France or like Sweden and Norway where the R and D effort of business firms is largely financed by government funds.

This explains why, in an international comparison, the proportion of industry as a performer of total R and D expenditure in the Netherlands was below the average for 17 OECD countries, while its relative importance as source of funds was far higher than the average for the same countries.

There is close concordance between the relative data as measured by expenditure (58.1% of the total) and by manpower (59.2% of the total).

Table 25. MAIN INDICATORS CONCERNING THE R AND D EFFORTS IN 17 OECD MEMBER COUNTRIES

COUNTRY	GERD[1] IN MILLIONS OF US $ 1967	BUSINESS ENTERPRISE SECTOR				FUNDING/PERFORMANCE 1967	TOTAL MANPOWER WORKING ON R AND D	MANPOWER WORKING ON R AND D IN THE BUSINESS ENTERPRISE SECTOR	BUSINESS ENTERPRISE R AND D MANPOWER AS A % OF TOTAL R AND D MANPOWER
		AS PERFORMER MILLIONS US $ 1967	% OF GERD 1967	AS SOURCE OF FUNDS MILLIONS US $ 1967	% OF GERD 1967				
Austria	62.2	39.4	63.4	36.5	58.6	91.4	6,620	4,111	62.1
Belgium	170.6	117.6	68.9	107.6	63.1	91.5	19,750	12,580	63.7
Canada	563.5	212.5	37.7	174.7	31.0	82.2	51,700	18,605	36.1
Denmark	64.9	34.1	52.5	32.9	50.7	96.5	6,270	4,170	66.5
Finland	40.2	21.9	54.5	22.4	55.8	102.3	5,154	2,865	55.6
France	2,506.0	1,358.8	54.2	788.2	31.5	58.0	193,437	112,[illegible]	58.3
Germany	2,066.3	1,420.7	68.8	1,190.5	57.6	83.8	202,866	146,073	76.6
Greece	11.3	3.7	32.5	3.7	33.1	100.0	2,738	617	20.9
Ireland	16.9	6.3	37.3	6.3	37.6	100.0	2,881	721	25.7
Italy	447.1	271.1	60.6	257.9	57.7	95.1	49,939	25,018	50.1
Japan	1,684.1	1,052.7	62.5	1,057.8	62.8	100.5	358,275	209,139	58.4
Netherlands	513.6	258.3	50.1	294.1	57.3	99.6	50,286	25,166	50.2
Norway	66.7	36.7	55.5	30.3	45.5	82.6	7,327	3,712	50.6
Sweden	336.1	234.5	69.9	187.1	55.6	79.8	26,744	19,161	76.5
Switzerland	302.9	232.7	76.5	237.5	78.1	102.9	16,934[3]	7,258[3]	72.0[3]
United Kingdom	2,486.1	1,804.3	66.3	1,057.1	43.0	64.9	-	-	-
United States	23,366.7	15,561.9	66.6	7,556.5	32.6	47.5	551,200[3]	371,800[3]	76.9[3]
Average	-	-	64.5	-	37.9	87.1			

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1. GERD = Gross Expenditure on R and D.
2. Qualified Scientists and Engineers and Technicians only.
3. QSE only.

SOURCE: OECD, 1967.

In view of the secrecy prescribed by law and also of the difference in classification, the Netherlands Central Bureau of Statistics was unable to submit a detailed breakdown of the R and D data by normalized international (ISIC) categories. For these reasons, the following branches were grouped together into one global group:

- aircraft and missiles;
- electrical industry;
- precision engineering;
- ferrous metals, non-ferrous metals and fabricated metal products;
- motor vehicle industry and shipbuilding.

Furthermore, the chemical industries category also included drugs and oil refining. The tobacco industry was integrated into the food industries group. The diamond industry was classified with the building materials (stone, clay and glass) industry.

According to Table 29 intramural expenditure on R and D is concentrated in two main groups of industries:

- metal products and machinery as defined above (about 50% of total industrial R and D);
- chemical industry (about 35% of total).

In other words, these two groups account for more than eight-tenths of total intramural expenditure on R and D in the business enterprise sector. All other industries are relatively modest performers. Only food, drink and tobacco stands out among them with a proportion of 5.6% of total intramural expenditure.

No figures are available with respect to the source of funds for intramural expenditure on R and D by industrial branches. Table 30 indicates these sources for the whole of the business enterprise sector.

Relative to major industrial countries, the contribution of the Netherlands Government to intramural R and D in the business enterprise sector appears low. This can be attributed partly to the structural pattern of Netherlands business firms and partly to the fact that the Government supports industrial organisation of applied research (TNO), which is supposed to carry out its research projects in close contact with industry and its needs. Besides the development credits given by the Government were still in an initial phase in 1967.

Table 12. MAIN INDICATORS CONCERNING THE R AND D EFFORTS OF THE NETHERLANDS BUSINESS ENTERPRISE SECTOR BY BRANCH OF INDUSTRY

	TOTAL INTRAMURAL EXPENDITURE ON R AND D IN THE BUSINESS ENTERPRISE SECTOR		EXPENDITURE ON R AND D IN THE BUSINESS ENTERPRISE SECTOR BY TYPE OF ACTIVITY (PERCENTAGES)		MANPOWER WORKING ON R AND D IN FULL-TIME EQUIVALENTS		
	MILLION GUILDERS	PERCENTAGES	BASIC AND APPLIED RESEARCH	DEVELOPMENT	TOTAL MANPOWER	TOTAL MANPOWER (%)	QSE
1. Agriculture, forestry, hunting, fishing	-	-	-	-	-	-	-
2. Mining and wells	4.5	0.6	15.4	84.6	154.0	0.5	43.0
7. Chemical, drugs, petroleum products	355.0	25.2	30.5	69.5	6,755.0	23.5	2,420.0
11. Machinery (including aircraft and missiles, electrical products, instruments, ferrous metals, non-ferrous metals, fabricated metal products, motor vehicles, shipbuilding, other transport, equipment)	850.0	59.5	23.6	76.4	15,600.0	55.2	4,800.0
20. Food and drink, tobacco	55.0	3.8	48.3	51.7	1,755.0	5.9	385.0
21. Textiles	26.9	1.9	28.7	71.3	630.0	2.1	170.0
22. Rubber	7.5	0.7	28.0	72.0	295.0	1.0	93.0
23. Sub-total of 20., 21., 22.	89.7	6.1	43.[illegible]	57.2	2,683.0	9.0	658.0
25. Clothing, footwear, leather	3.4	0.3	20.6	79.4	115.0	0.4	37.0
26. Wood furniture	0.7	0.0	28.6	71.4	100.0	0.1	43.0
27. Paper	7.3	0.7	7.0	93.0	223.0	0.7	71.0
28. Printing and publishing	1.5	0.1	45.0	55.0	47.0	0.2	15.0
29. Stone, clay and glass	6.0	0.5	36.2	63.8	253.0	0.9	65.0
30. All other manufacturing	-	-	-	-	-	-	-
31. Sub-total of 25/30	35.0	2.4	32.6	67.4	824.0	2.8	205.0
32. Total manufacturing	1,343.5	96.8	31.2	68.8	28,668.5	96.5	7,763.0
33. Utilities	3.6	0.3	40.0	60.0	82.0	0.3	23.0
37. Trade, banking, insurance, real estate, construction, communications, transportation, storage, engineering and technical services, miscellaneous services and other activities	27.0	2.5	27.8	72.2	810.0	2.8	193.0
40. Total: utilities, construction, etc. (33/37)	30.6	2.8	28.6	71.4	900.0	3.0	215.0
41. Total: all industries	1,380.0	100.0	31.0	69.0	29,700.0	100.0	8,000.0
42. Total in thousand US dollars (at official exchange rate)	388,342.3	-	-	-	-	-	-

SOURCE: OECD, 1967.

Table 30. SOURCES OF FUNDS IN THE BUSINESS ENTERPRISE SECTOR
1967

	MILLION GUILDERS	AS PERCENTAGE OF TOTAL
Own funds	1,042	96.5
Government	10	0.9
Other enterprise and other government	13	1.2
Abroad	15	1.4
	1,080	100.0

SOURCE: Ministry of Education and Sciences.

2. INDUSTRIAL R AND D BY TYPE OF COST AND TYPE OF ACTIVITY

a) Industrial R and D by type of cost

A meaningful analysis of intramural expenditure on R and D by type of cost can be realized only when homogeneous figures for several

Table 31. INTRAMURAL EXPENDITURE ON R AND D IN THE BUSINESS ENTERPRISE SECTOR BY TYPE OF COST
1967
(As percentage of total)

	LABOUR COST	OTHER CURRENT COSTS	TOTAL CURRENT EXPENDITURE	CAPITAL EXPENDITURE	TOTAL EXPENDITURE ON R AND D
Chemical industry ..	50.0	31.6	81.6	18.4	100.0
Metal products and machinery	61.8	27.3	89.1	10.9	100.0
Food, drink and tobacco	50.0	25.0	75.0	25.0	100.0
Other industries	67.0	22.0	89.0	11.0	100.0
	56.9	27.8	84.7	15.3	100.0

SOURCE: OECD, 1967 Statistical survey.

years or periods of time are available. This is not yet the case: the breakdown by major industrial groups only exists for 1967.

In comparison with other Member countries of the OECD for which similar figures are available, the above breakdown by type of cost suggests that the Netherlands lies somewhat above the average as far as labour is concerned. However, it has relatively the highest figure in respect to capital expenditure on R and D. *

The proportion of capital expenditure was particularly high in the food, drink and tobacco industries on one hand and the chemical industry on the other. It is the relative weight of this latter that seems to influence the overall figure for the business enterprise sector.

b) Industrial R and D by type of activity

According to the 1964 statistical survey, the expenditure on R and D in the business enterprise sector was as follows: fundamental research 25.5%, applied research 23.0% and development 51.5%.

Table 32. INTRAMURAL EXPENDITURE ON R AND D
BY TYPE OF ACTIVITY IN THE BUSINESS ENTERPRISE SECTOR
1967
(As percentage of total)

	BASIC RESEARCH	APPLIED RESEARCH	DEVELOPMENT
Belgium	6.5	41.7	51.8
Canada	4.7	25.9	69.4
Denmark	[1]	19.0[2]	81.0
France	[1]	38.5[2]	61.5
Germany	5.1	[3]	94.9[4]
Italy	3.0	36.4	60.6
Japan	10.2	28.4	61.4
Netherlands[5]	31.0[4]		69.0
Norway	3.6	30.5	65.9
Sweden	0.7	13.7	85.6
United Kingdom	3.4	21.9	74.7
United States (1966)	3.9	18.2	77.8

1. Included in applied research.
2. Including basic research.
3. Included in development.
4. Including applied research.
5. OECD estimates based on 1964 and 1967 national publications.

SOURCE: International Survey on Resources Devoted to R and D in 1967 by OECD Member Countries, OECD, May 1970.

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* International Survey on Resources Devoted to R and D in 1967 by OECD Member Countries, Vol. 1, Business enterprise sector, OECD Directorate for Scientific Affairs, Paris, May 1970.

In the 1967 statistical survey fundamental research and applied research were given together, as a meaningful separation was thought to be impossible.

There seems to be a relative increase in development activities in the business enterprise sector between 1964 and 1967. However, it must be stressed that the two surveys are hardly comparable.

On the basis of the 1967 survey, the comparison with selected OECD Member countries indicates that the Netherlands allocated to development activities 69% of total expenditure on industrial R and D. This is largely below the relative figures for Germany (95%), Sweden (85.6%), the United States (78%) and the United Kingdom (75%) but on about the same level as Canada and above that of other OECD countries.

3. PERSONNEL EMPLOYED IN R AND D ACTIVITIES

The business enterprise sector accounted for 59.2% of the total manpower employed in 1967 in R and D activities in the Netherlands. In full-time equivalents 29,700 persons were involved in industrial R and D and about 8,000 of these could be considered as belonging to the category of qualified scientists and engineers.

Table 33. MANPOWER EMPLOYED IN R AND D AND EXPENDITURE ON R AND D BY GROUPS OF INDUSTRIES
(As percentage of business enterprise sector)

	MANPOWER EMPLOYED IN R AND D	EXPENDITURE ON R AND D
Chemical industries	30	35
Metal products and machinery .	55	51
Food, drink and tobacco	6	6
Other industries	9	8
Total business enterprise sector	100	100

SOURCE: International Survey on Resources Devoted to R and D in 1967 by OECD Member Countries, vol. 1, OECD, May 1970.

The breakdown by major industrial groups as percentage of total R and D manpower can be compared with the breakdown of expenditure on R and D by the same groups.

Broadly speaking, the two series largely coincide but show a greater intensity of expenditure per person employed in the chemical industries and a relatively lower intensity of expenditure in metal products and machinery.

This can be expressed in more detail in a tentative calculation of expenditure on R and D per person employed.

The current expenditure on R and D per person employed was relatively highest in the chemical industries, followed by metal products and machinery. In food, drink and tobacco industries and in all other industries the level of expenditure on R and D per person employed in R and D activities was fairly similar but distinctly lower than in chemicals and in the metal products and machinery sector.

Table 34. EXPENDITURE ON R AND D PER PERSON EMPLOYED IN SELECTED GROUPS OF INDUSTRIES

1967

	NUMBER OF EMPLOYEES IN FULL-TIME EQUIVALENTS	TOTAL CURRENT EXPENDITURE ON R AND D (MILLION GUILDERS)	LABOUR COST (MILLION GUILDERS)	EXPENDITURE PER PERSON EMPLOYED	
				TOTAL	LABOUR COST
				(GUILDERS)	
Chemical industries .	7,492	258	162	34,300	21,200
Metal products and machinery	13,883	409	284	29,700	20,500
Food, drink and tobacco	1,508	39	26	25,900	17,200
Other industries	697	18	13	25,800	18,700

SOURCE: Ministry of Education and Sciences.

4. INTRAMURAL EXPENDITURE ON R AND D BY SIZE OF FIRM

In order to illustrate the breakdown of expenditure on R and D according to the size of business firms the most recent figures are those made available by the Netherlands Central Bureau of Statistics for the year 1964.

When considering these figures, especially in respect of small and medium-sized firms, the activity of the industrial organisation TNO and the work of branch research associations which often collaborate with the TNO specialized institutes for the sake of a given industry, have to be taken into account.

In 1964 the average intramural expenditure on R and D by small firms (under 200 employees) was less than 29,000 guilders per firm. This figure is also applicable to the larger firms in this category, namely those with 100-200 employees. This amount was manifestly far too small to make a continuous development activity at a reasonably technical level possible.

As far as the medium-sized firms (200-1,000 employees) were concerned, average R and D expenditure amounted to 60,000 guilders in 1964. Even this amount was hardly sufficient for R and D activities to be performed systematically. The most active firms in this category were to be found, as can be expected, in the chemical and pharmaceutical branches. The average expenditure on R and D in these industries could be estimated at 300,000 guilders per firm for those with 200-500 employees and more for those employing 500-1,000 persons.

Apart from the chemical and pharmaceutical industries, the other medium-sized firms (about 90% of the total of this category) devoted altogether 41.8 million guilders to R and D activities in 1964, that is an average of 50,000 guilders in the category of 200-500 employees and less than 100,000 guilders in the category of 500-1,000. This amount seems large enough to enable these firms to perform meaningful technical innovation but again not through their own intramural R and D activities.

Finally, the 169 large corporations with more than 1,000 employees - excluding the so-called "Big Five": Philips, Shell, AKZO, Unilever and Dutch State Mines - spent a total of about 120 million guilders in 1964 on intramural R and D activities, that is, an average of about 750,000 guilders per firm. According to the Committee of the Netherlands Society for Commerce and Industry in 1967, it was doubtful whether sufficient progress had been made in the industrial laboratories of the medium-sized and large firms in the Netherlands.

5. THE "BIG FIVE" AND THE CONCENTRATION OF R AND D

It is thus clear that there is a huge difference between these firms and the "big five". The latter carry out the majority of R and D activities in the business enterprise sector. In 1964 they spent about 428 million guilders for R and D purposes in their own laboratories, while total expenditure on R and D in the Netherlands industry amounted to 648 million guilders. These multi-national corporations were responsible for about 64% of overall expenditure on R and D in the business enterprise sector. In the field of fundamental research, the "big five" carried out 80% of the industrial total.

It follows that these corporations play an important role in R and D activities and place the Netherlands in a special position compared with other countries of same or larger dimensions, as they link the domestic R and D effort to world-wide trends. They carry out many research projects in the Netherlands with a view to making the results available to their affiliated companies, subsidiaires or establishments abroad, which thus benefit by the work of the home laboratories.

Table 35. GENERAL DATA ON THE FIVE BIG CORPORATIONS IN THE NETHERLANDS
1969

	NUMBER OF EMPLOYEES	TOTAL SALES	EXPENDITURE ON R AND D
		MILLION GUILDERS	
A. World			
Shell	173,000	36,214	450
Unilever	326,600	21,829	200
Philips	340,000	13,023	900
AKZO	100,300	6,366	200
Dutch State Mines	18,000	1,200	50
B. Netherlands			
The above five firms jointly	180,100		850
Personnel employed in R and D	17,700		

SOURCE: Five corporations.

According to the estimate for 1969, expenditure on R and D by the five big corporations amounted to about 1,800 million guilders if all their world-wide activities are considered jointly. In relative terms, the most research-intensive was Philips, with about 900 million guilders.

If R and D activities in the Netherlands alone were considered separately, the five firms together spent about 850 million guilders in 1969.

Each of the five corporations thus appears as a major research centre contributing to the high level of Netherlands industrial research and of the research community in general. It seems appropriate, therefore, to give a brief account of R and D activities and the research organisation of each of these firms.

a) N.V. Philips Gloeilampenfabrieken

Founded in 1891 as a Netherlands lamp-bulb industry, the N.V. Philips Gloeilampenfabrieken is at present a world-wide organisation, with its headquarters in the Netherlands.

It covers a wide range of products in the consumer, industrial and professional sectors whose centre of gravity is in the light electric and electronics area. This diversification of interests is closely related to prior activity in the company's corporate research. The origin of nearly all the product divisions, each with its own development laboratories, can be traced back to results of work carried out in these research laboratories.

Philips has production and development centres in many countries. Besides the main research laboratory in the Netherlands, there are five other research laboratories in other European countries.

The size of research activities, together with their international character, makes it difficult, if not impossible, to indicate with precision which part of the expenditure on R and D is spent in the Netherlands and how much of the research is done in other countries.

A considerable amount of the research is of a basic nature. It is controlled essentially by scientific merit and is independent of the consent or disapproval of operational divisions. This work - for example, molecular biochemistry and biophysics, superconductivity and superfluidity - is an absolute necessity for basic innovation. When common R and D projects are started, all necessary skills are secured from the beginning both in research and development work in order to maintain continuous interaction. The willingness of the divisions to co-operate in this respect is a measure of the need they see for the innovation under consideration. This is so because the central research organisation is financed by a levy on the divisions quite independent of the development within the divisions. The management of the divisions, however, is free to decide which part of its budget is allocated to its own development.

In order to make full use of its freedom to plan new products and especially complicated systems for the future, research management prefers not to rely on second-hand information from existing manufacturing units and marketing people of the company. A group has therefore been set up in the research laboratory with a view to evaluating possible research projects for to-morrow's needs and markets. It is considered essential that both the technical capacities of the laboratories and the social sciences should be made use of in this group. As the present methods of technological forecasting are still crude, it is necessary to explore their limits and develop more reliable and more creative methods.

b) Royal Dutch Shell Group

The importance of the Royal Dutch Shell Group is determined by the fact that the Dutch parent and holding companies and a number of service companies have their headquarters in the Netherlands. Moreover, Netherlands Shell is engaged in all stages of the oil industry as well as the petro-chemical industries and, recently, in metal-mining.

Research is regarded in Shell as an indispensable activity for finding leads and exploring new directions resulting in improved or new products and manufacturing processes. Probing for new possibilities proceeds at two levels. One can be described as extrapolation of the existing business, providing for its logical quantitative and qualitative extension and rejuvenation; and the other, management, considering research as one of its main observation posts, must closely follow social developments and be constantly prepared to adjust its position by embracing new opportunities and branching out into new fields that supplement and may eventually replace existing business.

Shell's early entry into the chemical industry and recent acquisition of metallurgical interests are illustrations of this policy. Research cannot play its part properly in this process if it has to operate as an isolated entity, launching new ideas to be taken up or left. Efforts are made, therefore, to tie research up with the rest of the business without tying it down.

On the laboratory side it has been found that, for long-term development in particular, a harmonious effort is best ensured by concentrating the work in large units. Besides favouring horizontal communication, this makes it possible to use specialized skills more efficiently and to tackle complex problems. Also, fundamental research groups run less risk of losing touch with reality when they work in such an environment.

Most of Shell's research is carried out in three countries, the Netherlands, the United Kingdom and the United States. Each laboratory has a well-defined sphere of research activity.

The main directions of research in the three laboratories in the Netherlands are the following:

i) Development of rational exploration and production methods for oil, including secondary recovery;

ii) Development, from the test tube to the pilot plant, of oil and chemical manufacturing processes, including new types of equipment and construction materials, measurement and control devices and concepts, and analytical methods;

iii) Mutual adjustment of materials, processing methods and applications in the field of macromolecular products.

Although a great array of skills and knowledge is available in the Group's laboratories in and outside the Netherlands, a possible lack of in-house expertise or of manpower may occasionally force Shell to sponsor research at an outside research institute or in a university. However, the amount of this kind of work is small in comparison with the total research effort.

c) Unilever

The wide range of products of this corporation is spread over a number of product groups, each directed and co-ordinated by a member of the parent board. There are food groups (a) margarine, edible oils and fats, dairy products, etc. (b) deep-frozen products, dried soups, mayonnaise, jams, drink, etc., (c) meat and allied products. The other groups are (d) detergents, (e) toilet preparations, including tooth-paste (f) chemical products.

Research and development at Unilever is mainly carried out in the laboratories belonging to Unilever Research, a corporate organisation headed by a member of the parent board.

The budget and the work of Unilever Research is strongly controlled by the product groups. The amount of money to be spent on R and D in each product group area is determined yearly by the product group co-ordinator with a view to long-term continuity. The programme of work in each product group is agreed upon between Research and the product group.

Though most of the work of Unilever Research belongs (in terms of the Frascati Manual) to the development category, the research climate is such that in important areas of Unilever activity research problems can be approached in scientific depth. In this way a sound basis for innovation is assured. This last aspect is reinforced by the fact that a percentage is added to the product group funds to serve as a central fund for corporate research.

Most of the products of Unilever have to be in line with local taste and custom which varies widely in different countries. A close link between consumer and market research is needed to direct the innovation towards profitable products. For the same reason a considerable amount of development work is carried out in local development units attached to a large number of factories in different countries.

The Netherlands laboratories work in close collaboration with the laboratories in the United Kingdom and in the United States. The laboratories in Vlaardigen and Duiven work under one management.

d) AKZO

AKZO N.V. is a multinational company which has 160 plants in 40 countries. It has its seat in the Netherlands, where the Group employs nearly 35,000 people. Measured by proportions in the present-day European chemical industry and on the basis of its sales figure AKZO ranks seventh in Europe, among the chemical concerns of the world it occupies eleventh place.

The production programme covers semi- and fully-synthetic fibres, plastics, synthetic leather, a large variety of inorganic and organic chemical products, ethical and proprietary drugs, toilet articles and cosmetics, foodstuffs, paints and lacquers, adhesives, binding agents, paper and disposables, detergents, cleaning agents and textile machinery.

AKZO's policy in the field of R and D is aimed at creating and maintaining the scientific and technical knowledge that is to contribute significantly towards the realization of the Group's business objectives. These research and development activities can be roughly divided into:

i) Supporting research and development to improve business results with existing processes, products and applications;

ii) Innovative R and D with respect to new products and applications in existing markets and projected new markets;

iii) Explorative research to complement the abilities with knowledge relevant to the development of the Group.

Research at divisional level works for the division and is financed by the division's management. The managements of the individual divisions which establish their R and D programmes consistent with the division's strategy, are responsible for their execution as regards efficiency and quality, both in the short and the long term.

Corporate research financed by the AKZO holding company is performed on behalf of the whole group, in close consultation with the divisional research. Emphasis is laid on explorative research with the additional background and methodological support of the divisional research.

The principal research and development centres are in Arnhem, Henegelo, Amsterdam, Oss, Sassenheim and Deventer. All this implies that scientific education in the Netherlands, qualitatively and quantitatively, exercises a great influence on AKZO's R and D activities. However, a constant effort is made at internationalization: this is particularly true in respect of the pharmaceutical laboratories in Oss, where research workers from 22 different countries are employed.

e) Dutch State Mines

Dutch State Mines was founded by the Netherlands Government in 1901 as a coal-mining company. Around 1930 it entered the fertilizer field. Since then it has developed as a major producer of chemicals. The main areas of activity are:

i) energy, where the last coal-mine will be closed in 1972 but a big interest remains in the natural gas area;

ii) fertilizers, started in 1930 and now a large diversified production field;

iii) organic chemicals, where the main activities are the fabrication of raw materials for fibres;

iv) poly-chemicals. DSM entered the plastics field around 1960; it is nowadays a rapidly-expanding activity of major importance to DSM growth.

Dutch State Mines has always been a science-based industry. Already in the late 1920's R and D activities were started in coal-mining, followed in the early 1930's by research activities in the chemical field.

The R and D policy of DSM has been founded on three main lines of thought:

i) To remain competitive by improving and rationalizing its operations through its own research;

ii) To make the best use of the available raw materials by developing new processes;

iii) To licence knowledge acquired by the DSM research activities to other companies in order to make the best use of it.

The research activities of DSM are carried out in its Central Laboratory in Geleen where around 1,200 people work. The research in this laboratory is organised into three main groups:

i) General and fundamental research;

ii) Inorganic research;

iii) Polymer and organic chemicals research.

The general and fundamental research is not controlled by the operational divisions of DSM and is to a good extent background research ranging from the study of the fundamental properties of polymers to the development of advanced process control systems.

The programme for the inorganic, polymer and organic chemicals research is controlled by a committee of managers from the operations and commercial departments and with the necessary continuity of the research capacity in mind, adjusted as well as possible to the company's actual needs. Recently a new organisations system was introduced to improve the integration of the research programme into the company's long-range strategic plan.

III

GOVERNMENTAL PROMOTION OF INDUSTRIAL R AND D

The basic principle of the Government's policy with respect to industrial R and D is that the primary responsibility for innovation rests with the management of industrial firms themselves.

In order to create a favourable climate for industrial initiative, the Government provides financial support for industrial R and D activities through direct support, for example subsidies, development credits on the one hand, and through specialized research organisations on the other.

As far as the tax treatment of R and D is concerned, no special regulations have been considered so far.

The Netherlands Government continues to give preference to a selective method of promoting industrial R and D.

1. DIRECT SUPPORT OF R AND D

The direct support of industrial R and D mostly takes the form of development grants or credits, as is shown by the figures for the years 1968-1971. This support can be divided into five major groups.

Relatively the most important item is the promotion of development activities in the field of nuclear energy. The sum of 40 million guilders was spent in this field in 1970, but expenditure was cut down to 27 million guilders in 1971. Development of technical processes and equipment in the civil sector ranks second in relative importance, with 21.5 million guilders in 1971. The support to the national aerospace programme comes next, with almost 15 million guilders in 1971 after a rapid increase during the period 1969-1970. Minor sums were devoted to the development of technical processes and equipment in the military sector on the one hand and to promotion of the development of computer science on the other.

The overall amount of direct support reached about 62 million guilders in 1970 and raised to 71 million guilders in 1971. This latter amount accounted for 5.9% of total government expenditure on R and D and for 4.3% of total industrial expenditure on R and D financed by industry's own funds.

Table 36. DIRECT SUPPORT OF INDUSTRIAL R AND D
BY THE GOVERNMENT
1968-1971

Million guilders

	1968	1969	1970	1971
Development of technical processes and equipment in the civil sector	9.5	12.0	8.15	21.5
Development of technical processes and equipment in the military sector	6.65	8.0	5.85	6.0
National Aerospace programme .	2.0	3.0	6.1	14.7
Promotion of development in the field of computer science	-	1.05	1.5	1.2
Promotion of development activities in the field of nuclear energy	19.0	24.9	40.0	27.3
Total	37.15	48.95	61.6	70.7
Percentage of total direct support of industrial R and D in				
- total government R and D expenditure	4.2	5.0	5.8	5.9
- total industrial R and D expenditure (own funds)	3.0	3.4	4.2	4.3

SOURCE: Ministry of Education and Sciences.

a) Civilian sector

The system of development credits is an interesting feature of the Netherlands policy for promoting industrial research. The Ministry of Economic Affairs grants development credits to industrial firms wishing to develop ideas or inventions but not able to finance these projects completely on their own. The development credit can contribute only a maximum of 70% of the total cost of the development phase. It does not aim at financing either the research activities preceding the development phase or those of the production phase.

The basic guidelines for granting development credits are the following:

- the project should be of a sufficiently general economic interest;
- there should exist a reasonable possibility of technical and economic success;
- it should be proved that the project cannot be carried out or could be seriously delayed without the development credit;
- the project should involve elements which can be regarded as an original contribution to the relevant state of the art in the Netherlands.

Moreover, firms applying for the credits should be able to participate to at least 30% in the development cost of the project and to direct the development findings into production.

The reimbursement of development credits (including 5% interest) depends in general on the financial results of the project. They do not have to be paid if the development does not turn out to be a success.

In order to prepare its decisions regarding individual requests for development credits, the Ministry of Economic Affairs avails itself of advice of the Central Institute for Industrial Development (Central Instituut voor Industrieontwikkeling) concerning the economic and technical aspects of the projects. The Central Institute is an autonomous organisation with governmental backing. Its role is to promote industrial development projects not only by giving advice to the Government but by carrying out orders from industrial branches or business firms.

On the advice of the Central Institute for Industrial Development, the Development Council - a special body composed of three independent experts - advises the Minister for Economic Affairs on the actual granting of development credits.

b) Military sector

The promotion of development in the military sector bears essentially on technical processes and equipment. Decisions concerning the financial support of projects in this category are prepared by the New Weapons Committee, and inter-departmental body for the promotion of research, development and production of military material in the Netherlands. This Committee is composed of high civil servants in several ministries: Defence, Economic Affairs, Finance, Foreign Affairs, Water Control and Public Works, and Education and Sciences. Moreover, it stimulates the participation of Netherlands industry in the supply of material to the national armed forces and the export of Netherlands products in this domain.

In general, government support takes the form of development orders to industrial firms. As a rule firms bear a third of the total cost of the project, whilst the Ministry of Defence and the Ministry of Economic Affairs finance the remaining two-thirds. Continuous links and deliberations help to ensure co-ordination between the two ministerial departments.

2. SUPPORT THROUGH SPECIALIZED INSTITUTIONS

According to Netherlands authorities, the Government supports industrial R and D through several specialized R and D institutions which in general enjoy the status of an autonomous non-profit organisation subsidized by regular budget appropriations. Their scope, structure and place in the institutional framework are described in more detail in Part Two.

Estimates for the years 1968-1971 suggest a fairly irregular development. In 1968 total funds attributed to the support of industrial R and D reached 102 million guilders. The amount fell below this level in 1969 and 1970 and rose again substantially in 1971 to 113 million guilders. This last sum accounted for 9.4% of total governmental expenditure on R and D. About half of this amount was accounted for by the Industrial Organisation TNO, some thirty per cent to the Reactor Centre of the Netherlands and the remainder to aerospace research and aircraft development, as is shown in the Table 37.

Each of these organisations has its own approach to the problems of promotion of industrial R and D in relation to its general scope and field of activity.

The Organisation for Industrial Research TNO belongs to the family of specialized institutions of the Central Organisation for Applied

Research created in 1934. It is by far the largest and its role is to promote efficient utilization of applied scientific research in industry and in economy in general.

Table 37. GOVERNMENTAL SUPPORT OF INDUSTRIAL R AND D THROUGH SPECIALIZED R AND D ORGANISATIONS
1968-1971

Million guilders

	1968	1969	1970	1971
Industrial Organisation TNO	52.3	48.6	51.2	55.3
Netherlands Reactor Centre	26.0	29.3	30.7	33.0
NLR: National Aerospace Laboratory	11.8	12.2	11.7	9.4
NIVR: Netherlands Agency for Aerospace Programmes	12.0	2.0	4.9	18.0
Total	102.1	92.1	98.5	113.2
Percentage of total indirect support of industrial R and D in:				
- total government R and D expenditure	12.1	9.9	9.2	9.4
- total industrial R and D expenditure (by own means) ...	8.7	7.0	6.7	6.9

SOURCE: Ministry of Education and Sciences.

The activities of the Organisation for Industrial Research can be broadly classified along the following lines:

- pioneering research, in, for example, organic chemistry, physics, biology;
- engineering research in particular with regard to materials, construction, productions, instrumentation, environmental technology;
- contributions to process and product development;
- evaluation of new products, machines and equipment and of new process developments, including testing;

- trouble shooting;
- specialized analytical and measurement services;
- information and training courses.

The Organisation for Industrial Research comprises 16 institutes. Some indications of their relative importance are given in Table 38.

There are several institutes working partly for the industry which do not belong to the Organisation for the Industrial Research but to other TNO institutions. Examples are the Technical Physics Department TNO and the Institute for Organic Chemistry TNO, both within the Central Organisation TNO, and the Institute for Cereals, Flour and Bread TNO, within the Organisation for Nutrition and Food Research TNO.

Several other institutes are affiliated to the Organisation for Industrial Research, such as those registered under the particular Netherlands form of foundation (stichting): Netherlands Ship Model Basin, Research Institute for Printing and Allied Industries TNO, Institute of Textile Clothing TNO and Experimental Station for Potato Utilization.

Most of these institutes tackle the research and development problems of specific branches of industry. Several others are specialized in given technical fields. Thus, for example, the Central Laboratory TNO covers the field of physics, chemistry and biology in order to conduct fundamental and exploratory research both to support the work of institutes oriented to specific branch technologies and to cope with external assignments. For its part, the Central Technical Institute TNO conducts research in the field of physical and chemical technology, heat and low-temperature technology.

Apart from the annual grant from the Central Organisation TNO, the Organisation for Industrial Research receives additional subsidies from the Government, in particular to promote its co-operative links with industry. These so-called "stimulating subsidies" are equal to:

a) the sum of the contributions which Netherlands firms research associations, etc., are ready - both individually and as groups - to give from their own resources for the TNO research programme over the 1954 level of these contributions;

b) the amount paid by the industry for a collective assignment.

As a result of this special promotional scheme collective research programmes have been developed in several branches of industry and in particular in the textile, timber and shipbuilding industries.

Table 38. INSTITUTES OF THE ORGANISATION FOR INDUSTRIAL RESEARCH TNO[1]

	NUMBER OF STAFF ON 31st DECEMBER 1969	EXPLOITATION EXPENDITURE (MILLION GUILDERS)			
		1968	1969[2]	1970[3]	1971[4]
Institute TNO for Building Materials and Building Structure, including Technical Centre for Fire Prevention	185	4.9	5.6	6.0	6.3
Central Laboratory TNO, including Analytical Centre	290	8.5	10.0	9.6	10.7
Central Technical Institute TNO	226	7.6	9.4	10.0	12.3
Forest Products Research Institute TNO	39	1.4	1.5	1.6	1.6
Instrumentation TNO	60	1.4	1.6	1.7	1.8
Plastics and Rubber Research Institute TNO	190	5.6	6.1	6.7	6.9
Institute for Leather and Shoes TNO	38	0.9	1.0	1.2	1.3
Metal Research Institute TNO, including Technical Foundry Centre and Technical Centre for Metalworking	270	8.9	9.5	11.0	11.9
Netherlands Ship Research Centre TNO	15	2.1	2.1	2.2	2.2
Paint Research Institute TNO	50	1.6	1.9	2.0	2.1
Institute TNO for Packaging Research	35	0.8	1.0	1.1	1.2
Fibre Research Institute TNO	241	6.3	7.0	8.0	8.3
Research Institute for Road Vehicles	22	-	-	1.0	1.2
Institute TNO for Mechanical Constructions	100	4.0	4.4	4.9	5.2
Total	1,761	54.0	61.1	67.0	73.0

The Industrial Research Organisation runs the Industrial Liaison Department to strengthen relations with industry.

1. Including also non-governmental support.
2. Provisional results.
3. Accepted budget 1970.
4. Draft budget 1971.

In the field of aeronautics and aircraft construction, research is carried out by the National Aerospace Laboratory (NLR) while the development work is done upon the order of the Netherlands Agency for Aerospace Programmes (NIVR).

The NLR has a staff of about 650 people. It is subsidized by the Government. The research activities of NLR are performed on the initiative of the foundation itself, or upon payment by order of NIVR, industry, the Ministry of Defence, the Department of Civil Aviation of the Ministry of Transport and of others. The Government is represented on the board of this institution by high officials of the ministries of Transport, Economic Affairs, Defence, and of Finance.

The task of the Netherlands Agency for Aerospace Programmes is to promote, co-ordinate and, if necessary, finance the development of aircraft material by Netherlands industry. The Fokker types F-27 and F-28 are examples of this policy.

The responsibility for the management of NIVR has been delegated by the Government to a board in which are represented the Government, the aerospace industry, the users of aerospace material and the institutions for scientific research in general, and for aerospace research in particular.

If a development project is approved by the NIVR Board in principle, it is submitted to the Government for the decision whether or not to include it in the NIVR development programme. Such an application is accompanied by a proposal concerning the share that the NIVR is ready to bear in the total of development costs. When the Government's approval has been obtained, the NIVR concludes a development contract with the manufacturer concerned.

The funds of the NIVR consist of:

a) an annual government subsidy;

b) exploitation yields of the results of the development and research orders;

c) possible contributions or subsidies from other sources.

The government subsidy is charged to the budget of the Ministry of Transport and Water Control and Public Works. It is fixed annually on the basis of the budget proposal submitted by the NIVR Board. This subsidy, increased considerably for 1971 because of the participation of the Netherlands in the European airbus programme and the NIVR's involvement in the supervision of the national astronomical satellite project, is charged to the budget of the Ministry of Economic Affairs.

A special case, and an example of a co-operative type of R and D institute, is KEMA, a company entrusted with testing research in the field of electronical equipment. It was created in 1927 by municipal and provincial electricity corporations and has developed into an important institution disposing of a series of laboratories all over the country.

Apart from research in, and testing of, materials to be used in all fields of power production and distribution, KEMA also carries out investigations in related fields, such as corrosion, air pollution and chemical and physical agents which come into consideration in electricity supply.

3. INDIRECT SUPPORT OF R AND D ACTIVITIES

There is no particular budget or fiscal incentive programme in the Netherlands. The tax treatment of R and D expenditure seems to present many more difficulties than in other industrialized countries. This is due to the fact that the Section 9 of the Income Tax Act lays down that the taxable profit shall be determined on the basis of sound commercial practice. With regard to a point like deductible depreciation, this means that variations in the period and method of depreciation are conceivable but no clear distinction is made in respect of research expenditure.

Nevertheless, as a general rule, research and development expenditure - insofar as it is direct expenditure (direct research costs such as staff, materials, etc. and not premises and plant, which must be activated normally) - is to be deducted from profits in the year in which it is incurred.

In certain cases, however, activation of research and development expenditure (i.e. including the value of its results as assets in the balance sheet) may be permitted for tax purposes. If it is activated (where activation is permitted) relief is granted in relation to the sum invested.

This became clear during the parliamentary debate on the 1964 Income Tax Act. Before that date, when the tax law of the wartime occupation regime was still in force, the Guide on the application of investment relief laid down that no investment relief could be granted in relation to research expenditure because it involved an activated item of expenditure.

At present relief can be granted if the expenditure on R and D is activated and if it is sufficiently in the nature of an operating asset, i.e. if over a period of years, it has some value to the firm as, for example, a value represented by a patent.

Here follows a list of the cases in which it is possible to activate expenditure on R and D for tax purposes.

This is a question which - as with all other operating expenditure - is governed by the concept of sound commercial practice. In connection with the preparation of the ministerial directive to tax inspectors, the Corporation Tax Inspectorate in Amsterdam drew up the following classification, which is considered very useful by the Direct Tax Department.

a) Firms whose object it is to carry out research and development

This results in a patent, a licence, etc.; something is produced for sale (in fact a specific product related to the patent, etc.) it is therefore not an operating asset. Activation is not permitted and it is not eligible for investment relief.

b) Firms which carry out research and development as a part of their corporate activities

This can concern:

i) regular research costs for current production. This is, in fact, a part of the cost price of current production; there is therefore no activation and no investment relief;

ii) costs incurred in seeking new products, new production techniques, new raw materials, etc., this is genuine research, which can be divided into (1) research and specific projects, (2) fundamental research, (3) intermediate area: including research which is directed towards a specific end but does not yield tangible results though adding to fundamental knowledge. Only items under (1) would qualify for activation, while the items under (3) would be doubtful.

In reality, operating with a term such as "sound commercial practice" means that there is a certain latitude in determining profits. Thus an enterprise which has been operating at a loss over a period of years will be inclined to offset as little expenditure as possible against the profits. The later the loss is absorbed in the accounts the more chance there is of the tide turning in the meantime and of a possible return to profitability; in this case the firm would tend to spread the activation over several years. On the contrary, a profitable firm will offset as much expenditure as possible against profits in one year.

4. TRENDS IN GOVERNMENT POLICY IN RESPECT TO INDUSTRIAL R AND D

The Government is of the opinion that a dynamic technological development which results in a continuous improvement of production methods and products constitutes an indispensable pre-requisite for further growth in a high-quality industry capable of holding its own in the face of international competition.

The responsibility for the technical level, and the rate at which improvement and innovation are effected, rests primarily with industrial management. This does not alter the fact that the Government, in its endeavours to bring about a favourable industrial climate, should also give active encouragement to research and development activities.

Table 39. DIRECT AND INDIRECT SUPPORT OF INDUSTRIAL R AND D BY THE GOVERNMENT
1968-1971

Million guilders

	1968	1969	1970	1971
Total direct and indirect governmental support for industrial R and D (including indirect support to some small organisations)	139.2	141.0	160.1	183.9
Percentage of total direct and indirect governmental support for industrial R and D in:				
- total governmental R and D expenditure	16.5	15.1	14.9	15.3
- total industrial R and D expenditure (by own means) ...	11.9	10.8	10.9	11.2
- total national R and D efforts .	6.9	6.3	6.3	6.4

SOURCE: Ministry of Education and Sciences.

The instrument for granting fiscal advantages to this end is considered both ineffective and inappropriate. Preference is given to a more selective way of promoting industrial research and development.

In the past, Government policy in this field was focused predominantly on subsidizing specialized research institutions. In recent years, however, alongside this mediate form of support, room has been made increasingly for direct support to development work within industry itself. This form of support is expected to act not only as a swift and effective spur to technical innovation in industry but also as an incentive for setting-up a technical and organisational framework which is essential if an enterprise is to apply to its own development research findings obtained elsewhere. In this way, the yield from the indirect or mediate support may be expected to have a multiplier effect.

The idea of an increased support to industry has been endorsed by the advice issued by the Science Policy Council of the Netherlands. In view of the importance of industrial research and development for the future economic potential of the Netherlands and of the support for industrial R and D by governments in most industrialized countries, the Council recommended a relatively sharp increase in direct support to industry, in particular through development credits. As to the Industrial Organisation TNO, the Council suggested that its staff should be maintained at the current level until 1971. At the same time it recommended a decrease in Government support to research in the field of atomic energy.

The continuing and increasing tension between the requirements and the means available led the Government to subject important sectors of governmental concern to a critical analysis. The Ministries of Finance, Economic Affairs and Education and Sciences requested the Science Policy Council to draw up an advisory report on ways and means to increase the effectiveness of state-aided applied research - in particular that carried out by the TNO and the Reactor Centre of the Netherlands - with a view to promoting industrial innovation and to achieving optimal growth in the economy.

In its Interim Advisory Report (1968) and Progress Report (1969) the Science Policy Council gave some indications of its thinking on this subject.

According to these reports, the Industrial Organisation TNO carries out very useful activities in a number of sectors, in particular those relating to fundamental research, measurement, control and evaluation. However, it seems that the structure and working methods of this organisation are not entirely appropriate to research and development work. The Science Policy Council holds the view that R and D work should be carried out essentially within the industrial firms themselves, even in small and medium-sized ones, or at least in much closer cooperation with the TNO than has so far been possible.

Part Four

RESEARCH IN THE SERVICE OF THE COMMUNITY

I

DEVELOPMENT OF GOVERNMENT EXPENDITURE ON R AND D

One of the most characteristic features of Netherlands science policy is a close parallelism between the trend in government expenditure on R and D and the R and D effort in the economy.

From 1950 to 1965 government funds devoted to R and D expanded at a very high rate. They increased much more rapidly than both the gross national product and the total government expenditure, so that the relative importance of R and D activities represented a significant proportion of government expenditure and national income.

This development called for an evaluation of past government policies in this field. In order to provide a more rational basis for future action a "science budget" has been established since 1967, its aim is to link R and D effort to general objectives of the Government.

1. TOTAL EXPENDITURE ON R AND D

Broadly speaking, from 1950 onwards three periods can be distinguished in the development of government expenditure on R and D in the Netherlands.

During the first period, 1950-1959, which can be called a phase of edification, the average annual growth rate was of about 24%. This means that at current prices government expenditure on R and D increased almost eight-fold, from 22 million guilders in 1950 to 160 million guilders in 1959.

The second period, from 1959 to 1966, can be characterised as a phase of sustained expansion with an overall annual rate of growth of about 22%, bringing total government expenditure in R and D to 669 million guilders in 1966.

Finally, the third period extends from 1966 to 1971. This can be described as a phase of analysis and assessment, leading to an attitude of systematic and detailed evaluation and an idea of R and D policy linked more closely to the economic and social problems of the country. During these years the rate of growth slowed down to an average 12,5% per annum.

According to the opinion expressed by the Science Policy Council of the Netherlands in the "Interim advice on government expenditure for R and D in the period 1969-1971" and also in its progress reports, government expenditure on R and D should hence forward expand in a consolidated manner. Nevertheless, its rate of growth should exceed that of the overall government expenditure by a certain regular margin. There are several reasons for this:

- the social significance of R and D will continue to increase, because of the general tendency towards "scientification" in all major aspects of economic and social life;
- R and D expenditure in the higher education sector will increase rapidly, more or less in line with the teaching function, as a consequence of an expected rise in student numbers;
- R and D activities will generate a need for new techniques and more expensive instruments, and this "sophistication factor" will push up the costs of R and D work.

In addition to these trends, which are held to be practically inherent to the process of social acceptance of science, the R and D effort is generally justified on grounds of the international competitiveness of the Netherlands economy. This is by far the most vital issue for the Netherlands and one which no policy-maker can afford to minimise or neglect.

2. THE "SCIENCE BUDGET"

Since the first listing of government funds for R and D activities in 1967 the concept of a science budget has been continually improved.

The science budget should be understood as a compilation of all items earmarked by various ministries for the execution or promotion of R and D activities. As it now stands, it is essentially a general review and not a budgetary estimate in the true sense of the word, that is, a binding scheme of financial outlays in a given operational field of State

Table 40. GOVERNMENT EXPENDITURE ON R AND D

	GOVERNMENT EXPENDITURE ON R AND D (Million guilders)	TOTAL GOVERNMENT EXPENDITURE (Million guilders)	EXPENDITURE ON R AND D AS % OF TOTAL GOVERNMENT EXPENDITURE	EXPENDITURE ON R AND D AS % OF TOTAL GOVERNMENT EXPENDITURE EXCLUDING HIGHER EDUCATION SECTOR
Expenditure				
1964	464	14,463	3.21	1.65
1965	560	16,900	3.32	1.78
1966	669	18,773	3.56	1.93
1967	759	20,719	3.66	1.98
1968	852	24,346	3.50	1.93
1969	935	26,473	3.53	1.98
Budget estimates				
1970	1,071	28,315	3.78	2.07
1971	1,206	31,525	3.83	2.15

SOURCE: Ministry of Education and Sciences.

finances. However, an effort is made to keep it an independent exercise, a pluri-annual budgeting and programming of R and D activities.

Though it has limited value as an instrument of decision-making, the science budget has been useful as a conceptual and explanatory tool. It seems to have reached a sufficiently detailed stage of accounting to permit henceforth an efficient control of government funds and a progressive shift towards new societal goals.

The Science Policy Council is of the opinion that the picture of the R and D potential in the science budget could be improved by taking into consideration the large differentiation of institutes in the universities and institutions like TNO. The desired picture can, however, only be obtained when there is a real insight into the activities of all these institutes.

As to overall government expenditure on R and D, the 1971 science budget included a series of data on actual expenditure during the years 1964-1969 and on budget estimates for 1970 and 1971.

These figures show clearly that 1966 was a turning-point in the development of government R and D expenditure. Expressed as a percentage of total government expenditure, R and D funds amounted to 3, 21% in 1964 and rose rapidly to 3, 66% in 1967. This ratio regressed to 3, 50% in 1968. Budget estimates for 1970 suggest an increase to 3, 78% and for 1971 to 3, 83%.

The slowing-down of the growth rate is still more pronounced when the higher education sector is excluded. Expenditure on R and D in all other government sectors amounted to 1, 60% of total expenditure in 1964 and almost 2% in 1966. It regressed during the years 1967-1969 and is expected to recover to the previous maximum level in 1970 and 1971.

3. MINISTRIES AS SOURCES OF FUNDS

The annual drafting of a science budget has not brought a shift in the control functions. The responsibility for R and D funds rests with various ministries within the scope of their operational tasks.

As is shown in Table 41 government expenditure on R and D is strongly concentrated in a small number of major fields. As a source of R and D funds the Ministry of Education and Sciences, with almost 60% of total expenditure, in 1971, is a long way ahead, followed at an equal distance by the Ministry of Economic Affairs and the Ministry of Agriculture and Fisheries.

Table 41. GOVERNMENT EXPENDITURE ON R AND D BY MINISTRIES AS SOURCES OF FUNDS

Million guilders

MINISTRIES	1964	1965	1966	1967	1968	1969	1970	1971
							(BUDGET ESTIMATES)	
Education and Sciences	259.4	304.4	369.8	421.8	484.4	512.1	598.3	672.3
Economic Affairs	73.2	90.7	95.1	111.9	129.5	143.8	149.1	163.4
Agriculture and Fisheries	66.6	81.5	100.9	110.3	114.4	128.1	148.7	165.2
Defence	24.4	27.1	28.5	34.0	37.7	48.6	48.4	53.5
Social Affairs and Health	17.3	20.6	21.4	29.6	33.8	44.0	52.9	60.3
Transport and Water Management	10.5	19.4	31.2	31.1	30.9	30.5	37.8	48.5
Culture, Recreation and Social Welfare	6.5	8.8	9.3	10.3	10.6	13.6	15.8	18.3
Housing and Physical Planning	3.8	4.7	6.1	6.3	7.2	10.1	12.3	13.5
Foreign Affairs	1.2	1.3	5.7	0.7	1.6	0.8	2.4	5.7
Interior	0.9	1.6	1.3	2.7	1.8	2.8	3.8	3.6
Justice	0.1	0.1	0.1	0.4	0.4	0.8	1.0	1.1
Finance	-	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cabinet of the Vice-Minister President	-	-	-	-	-	-	0.1	0.1
Total	463.9	560.3	669.5	759.2	852.4	935.3	1,070.7	1,205.6

SOURCE: Ministry of Education and Sciences.

These three ministries jointly account for about 85% of total government expenditure on R and D and come thus far ahead of other ministerial departments.

These major sources of funds are followed by a group of three other ministries, Defence, Social Affairs and Health, Transport and Water Management, each with about 4% of the total.

The Ministry of Culture, Recreation and Social Welfare spends about 1.4% of the total on R and D and the Ministry of Housing and Physical Planning somewhat more than 1%. Other ministries play only a very modest role in financing R and D activities.

If the series of absolute figures is expressed in indices with 1964 as a reference year (Table 42), it is possible to analyse the relative growth of R and D funds by ministerial department.

A scrutiny of the eight principal sources of funds show a general inclination to favour the growth in social and community-oriented ministries. During the period 1964-1971, R and D funds grew much more rapidly than the average in the ministerial departments of Social Affairs and Health, Transport and Water Management, Housing and Physical Planning, Culture, Recreation and Social Welfare.

R and D funds allocated to the Ministry of Education and Sciences increased slightly more than the average overall government expenditure on R and D.

In three important ministries (Economic Affairs, Agriculture and Fisheries, Defence) on the contrary, the growth of R and D funds remained below the average government expenditure.

So far the difference in growth rates had not brought about a substantial shift in the breakdown of government R and D funds, as compared with the initial level of allocation to the R and D funds distributed by the production-oriented ministries, in particular Economic Affairs, Agriculture and Fisheries. Everything seems to indicate that this shift will continue to be progressive, as new tasks emerge in the areas of social and community concern.

4. FIRST DESTINATION OF R AND D FUNDS

The breakdown by sources of funds only indicates the scope of responsibility of various ministries in the distribution of government expenditure on R and D. Another set of statistical data describes the

Table 42. GOVERNMENT EXPENDITURE ON R AND D BY MINISTRIES AS SOURCES OF FUNDS

(Indices, 1964 = 100)

MINISTRIES	1964	1965	1966	1967	1968	1969	1970	1971
						(BUDGET ESTIMATES)		
Education and Sciences	100	117	143	163	187	197	231	259
Economic Affairs	100	124	130	153	177	196	204	223
Agriculture and Fisheries	100	122	152	166	172	192	223	248
Defence	100	111	117	139	155	199	198	219
Social Affairs and Health	100	119	124	171	195	254	306	349
Transport and Water Management	100	185	297	296	294	290	360	462
Culture, Recreation and Social Welfare	100	135	143	158	163	209	243	282
Housing and physical Planning	100	124	161	166	189	266	324	355
Foreign Affairs	100	108	475	58	133	67	200	475
Interior	100	178	144	300	200	311	422	400
Justice	100	100	400	400	400	800	1,000	1, 100
Finance	-	100	100	100	100	100	100	100
Cabinet of the Vice-Minister-President .	-	-	-	-	-	-	100	100
Total	100	121	144	164	184	202	231	260

SOURCE of absolute figures : Ministry of Education and Sciences, flow of these funds by "first destination", which is tantamount to a global repartition of basic receiving institutions.

The major part is allocated to the higher education sector, with almost half the total government expenditure on R and D. This part remained remarkably stable during the period 1964-1971, which seems to be in line with overall expenditure on higher education.

The second major destination was the sector of institutions subsidised mainly by the Government. This sector includes government-sponsored research institutions with legal status of foundation (stichting) considered to be more flexible and are better adapted to the role and aim of research than direct services of government agencies. The share of this sector was also relatively stable, remaining at about 18% of the total.

A major shift has been registered by the Organisation for Applied Research, TNO. This organisation's share fell from 13% in 1964 to an estimated 8.4% of the total in 1971.

A relative decrease was also registered in contributions to the international organisations, whose share in the total expenditure went down from 7.2% in 1964 to 4.2% in 1971.

The Organisation for the Advancement of Pure Research, ZWO, maintained, and even very slightly increased, its share to about 5% of the total.

The biggest increase was in the business enterprise sector, whose share was negligible in 1964 but which rose to an estimated 5.6% in 1971, due mainly to a tendency to grant aid to firms needing help to advance promising projects which are in the development phase.

The budget estimates for 1970 and 1971 allow for a distinction between current expenditure and capital outlays by first destination. According to these estimates, the capital outlays differ greatly from one group of institutions to another.

In the higher education sector, the share of capital expenditure was estimated at 28% in 1970 and 24% in 1971. In the group of institutions subsidised mainly by the Government the share of capital expenditure was 15% in 1970 and 13% in 1971. In the budget estimates of the Organisation for Applied Research, TNO, the capital outlays accounted for respectively 15 and 14% of the total.

In the government agencies the share of capital expenditure was estimated at 6 and 8% respectively. As to the Organisation for the

Table 43. GOVERNMENT EXPENDITURE ON R AND D BY "FIRST" DESTINATIONS

(1966-1971)

Budget estimates

Million guilders

FIRST DESTINATION	1966	1967	1968	1969	1970	1971
Higher Education Sector	289.5	315.9	375.5	418.5	493.7	539.9
Institutions (Srichtingen) financed mainly by Government	137.8	141.2	149.9	171.6	198.1	233.3
TNO	69.7	76.1	83.9	91.9	97.3	106.4
Business firms	8.9	17.4	35.1	49.0	61.6	70.2
Government agencies	35.9	49.1	58.2	56.2	64.5	73.1
ZWO	34.8	40.7	43.0	50.2	55.0	63.8
International organisations	48.8	52.0	64.4	58.7	48.6	52.8
Private-non-profit institutions	4.5	4.6	3.7	5.5	6.8	7.9
Others	5.8	19.3	26.9	33.8	45.2	58.2
Total	635.7	716.3	840.6	935.4	1,070.8	1,205.6

SOURCE: Ministry of Education and Sciences.

Table 44. GOVERNMENT EXPENDITURE ON R AND D BY FIRST DESTINATION AND TYPE OF COST[1]

1970 and 1971

	CURRENT EXPENDITURE				CAPITAL EXPENDITURE				TOTAL EXPENDITURE			
	1970		1971		1970		1971		1970		1971	
	Million Guilders	% of total	Million Guilders	% of total	Million Guilders	% of total	Million Guilders	% of total	Million Guilders	% of total	Million Guilders	% of total
Higher education	355	72	410	76	139	28	130	24	494	100	540	100
Government agencies	61	94	67	92	4	6	6	8	65	100	73	100
TNO	82	85	91	86	15	15	15	14	97	100	106	100
ZWO	50	91	58	91	5	9	6	9	55	100	64	100
Institutions mainly financed by Government	212	85	261	87	38	15	38	13	250	100	299	100

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[1] Not including business firms, international organisations, private non-profit institutes and non-classified items.

SOURCE: Ministry of Education and Sciences, based on figures in Table 9.

Table 45. GOVERNMENT EXPENDITURE ON R AND D BY MAIN SCIENTIFIC CATEGORIES

1966 - 1971

	NATURAL AND ENGINEERING SCIENCES		SOCIAL SCIENCES AND HUMANITIES		R AND D POLICY FUND	
	MILLION GUILDERS	AS % OF TOTAL	MILLION GUILDERS	AS % OF TOTAL	MILLION GUILDERS	AS % OF TOTAL
1966	555	87.4	80	12.6	-	-
1967	630	88.0	86	12.0	-	-
1968	732	87.1	108	12.9	-	-
1969	812	86.8	124	13.2	-	-
1970	910	85.0	156	14.5	5.2	0.5
1971	1,012	84.0	186	15.4	7.5	0.6

SOURCE: Ministry of Education and Sciences.

Advancement of Pure Research, ZWO, capital outlays accounted for 9% of the total expenditure of this organisation in 1970 and 1971.

According to a series of figures published in connection with the 1971 science budget, the major part of government expenditure on R and D was allotted to natural and engineering sciences. In 1966, these accounted for almost nine-tenths of the total (87.4%). This share decreased somewhat during the years 1967-1969 and diminished further in 1970 and 1971. It attained 84% of the total in 1971.

The social sciences and humanities received about 80 million guilders in 1966, or 12.6% of the total. Their share increased to 13.2% in 1969 and was estimated at 15.4% in the budget forecast for 1971.

On the recommendation of the Science Policy Council, a certain amount of money has been put aside since 1970 as a special fund for R and D policy. This is a lump sum which is not ascribed to any particular target but remains available for flexible intervention in case of special needs or new unforeseen but important developments. This sum is still very modest and accounts for only half of one per cent of total government expenditure on R and D.

5. GOVERNMENT EXPENDITURE ON R AND D BY "PURPOSES"

The breakdown of funds by ministries mainly indicates the channels through which R and D money flows to institutions of first destination. However, the crucial criterion on which to base science policy decisions is the breakdown by functional appropriation. Government expenditure on R and D is split up and classified by main "purposes". A considerable effort in this field has been made by international organisations, namely the OECD and the EEC. On the other hand, the Netherlands authorities have developed their own classification which is considered to respond best to their particular concerns and policy orientations.

The OECD classification is based on an identification of primary purposes or areas of relevance. It is assumed that a standard grouping of purposes over some period of time can give useful information to decision-makers, particularly as to -

a) the difference between the explicit science policy of a country and the "implicit science policy" revealed by the actual pattern of government expenditure on R and D;

b) the changes in priorities over periods of time and how this affects the overall pattern of R and D;

c) the comparison of weighting scales that Member countries attach to various purposes*.

As is shown in Table 46 the OECD classification distinguishes five major groups of functional appropriations:

1) National security and big science;
2) Economic development;
3) Community services;
4) Advancement of science;
5) Other activities.

Advancement of science is relatively the most important group, with almost 54% of total government expenditure on R and D in 1970. Advancement of science via general university funds is by far the biggest flow of government R and D money.

National security and big science accounted for about 18% of the total in 1970. Some 10% were devoted to civil nuclear research and the rest was divided between defence and civil space.

Economic development was practically of the same relative importance in 1970 (17.8% of the total). About 9% was accounted for by R and D activities in agriculture, forestry and fishing, whereas mining and manufacturing received about 6% and the remainder was allotted to other economic services.

Community services as a group received 9.4% of total government expenditure on R and D in 1970. The main items in this category were, in order of importance, health, public welfare, pollution and other community services.

Finally, other activities accounted for about 1% of the total in 1970, of which around half of one per cent was earmarked for aid to developing countries.

According to Table 46 the average annual growth rate of government expenditure on R and D was of 18.5% when calculated at current prices and of 12.5% at 1961 constant prices.

At current prices, the most rapidly-growing group was that of national security and big sciences with an average annual growth rate

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* OECD, R and D in OECD Member Countries - Trends and Objectives, (to be published).

Table 46. GOVERNMENT R AND D FUNDING BY OBJECTIVE

Million guilders, current prices

MAJOR GOALS	CLASSES	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
National security and big science ...	Defence	6.8	7.4	10.2	9.8	16.2	22.2	23.3	30.1	36.1	45.3	53.0	50.5
	Space	0.9	0.7	0.6	1.0	2.6	11.0	26.5	16.0	25.5	34.3	38.6	32.3
	Nuclear	19.0	21.9	29.6	36.4	44.1	55.0	62.0	75.2	85.5	94.3	99.0	117.2
Economic development ...	Agriculture	20.2	23.7	27.0	29.8	32.8	38.4	49.1	65.1	64.4	63.5	69.5	78.1
	Mining and manufacturing	19.4	23.8	21.3	25.6	25.8	35.9	45.5	58.4	59.6	73.3	65.0	66.9
	Services	2.5	2.5	2.9	3.3	3.9	5.3	6.7	9.2	10.7	12.4	16.4	20.5
Community services ...	Health	8.5	9.8	11.7	12.3	12.3	15.3	17.4	18.2	24.7	28.4	38.7	46.1
	Pollution	4.7	5.7	6.2	7.1	7.4	9.1	11.0	13.7	16.1	18.2	20.3	23.7
	Welfare	7.3	8.9	10.0	11.6	13.5	16.9	21.1	23.5	28.2	34.9	40.7	48.6
	Other community services	2.7	3.3	3.4	3.9	4.9	5.4	8.0	9.7	11.6	14.8	16.9	20.3
Advancement of sciences ...	Non-university	7.6	12.3	10.4	15.8	19.7	21.2	27.6	37.8	43.2	47.9	62.1	69.5
	University	71.5	84.4	109.3	133.1	153.7	225.9	259.0	305.5	348.5	381.3	410.3	484.5
Other	Dev. countries	0.2	0.2	0.2	0.2	0.3	1.3	1.5	6.0	1.1	2.1	2.8	5.3
	Miscellaneous	0.6	0.5	0.7	1.1	1.2	1.0	1.6	1.1	2.0	1.7	2.0	7.2
Grand total		171.9	205.1	243.5	291.0	338.4	463.9	560.3	669.5	759.2	852.4	935.3	1,070.7
Of which	Natural sciences and engineering	154.5	183.9	218.0	260.0	301.3	413.3	498.8	583.4	660.4	752.2	810.5	916.4
	Social sciences and human	17.4	21.2	25.5	31.0	37.1	50.6	61.5	86.1	98.8	100.2	124.8	154.3
Of which	National	162.6	200.1	229.7	273.9	316.1	430.2	509.1	617.1	699.9	788.3	876.9	1,022.4
	International	9.3	5.0	13.8	17.1	22.2	33.7	51.2	52.4	59.3	64.1	58.4	48.3

SOURCES: OECD and Ministry of Education and Sciences.

of about 20%. "Advancement of science" expenditure has been progressing at a rate of about 19% per annum.

Community services and economic development groups registered a growth rate below that of total government expenditure on R and D. Community services progressed at about 17.5% and the economic development group at about 15% per annum.

The framework for functional analysis elaborated by the EEC is articulated into twelve major groups: nuclear R and D, space exploration and technology, defence, earth environment, health, human environment, agricultural productivity, industrial productivity, computer science and automation, social sciences and humanities, general advancement of knowledge outside the university, general advancement of knowledge inside the university.

As is illustrated in Table 47 this framework can be further developed into a more detailed breakdown of R and D funds by category of research activity, scientific discipline, field of community interest, branch of industry, etc.

A comparison of R and D expenditure broken down along the lines of the EEC analytical scheme is given in Table 48 for the year 1969.

In 1969, the Netherlands Government spent relatively much less on nuclear research (9.9% of the total) than each of the other Member countries of the EEC. Its expenditure on space exploration and technology was also the lowest, in relative terms, among EEC Member countries, with 3.9% of the total as against an average 6.1% for the EEC.

Netherlands government expenditure was equally on the low side in the field of defence, with 5.4% of the total; this percentage was higher, however, than that of Belgium and Italy.

Contrarily, the Netherlands had the highest relative expenditure in 1969 in the groups relating to social and community problems, such as social sciences and humanities, health, human environment and earth environment.

It was relatively far ahead of other EEC Member countries in the field of R and D expenditure on general advancement of knowledge, particularly inside the higher education sector.

The figures published in the 1971 science budget can be broken down along the lines of the Netherlands classification of purpose of functional appropriation. A cross-matrix can then be constructed with

Table 47. GOVERNMENT EXPENDITURE ON R AND D, BY OBJECTIVE

in national currency

OBJECTIVES	1967		1968		1969		1970	
	'000 G.	%	'000 G.	%	'000 G.	%	'000 G.	%
1. Nuclear research and development	81,752	11.1	94,285	10.7	96,699	9.9	116,112	10.4
1.0 General research	2,195	0.3	2,375	0.3	2,065	0.2	2,219	0.2
1.1 Research for energy purposes	67,365	9.1	81,823	9.3	85,287	8.8	100,207	9.0
1.9 Other research	12,192	1.7	10,087	1.1	9,047	0.9	13,686	1.2
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
2. Space exploration and technology	22,959	3.1	35,322	4.0	37,907	3.9	32,358	2.9
2.0 General research	1,009	0.1	4,127	0.6	4,168	0.4	7,808	0.7
2.1 Launcher and satellite research	21,650	2.9	30,861	3.5	33,379	3.4	24,125	2.1
2.1.1 Launching systems	(10,000)	(1.3)	(17,000)	(1.9)	(17,000)	(1.7)	(5,700)	(0.5)
2.1.2 Scientific exploration	(11,650)	(1.6)	(13,861)	(1.6)	16,379	(1.7)	(18,425)	(1.6)
2.1.3 Space systems	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
2.9 Other research	300	0.1	-	-	360	0.1	425	0.1
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
3. Defence	28,196	3.8	45,366	5.2	53,067	5.4	51,162	4.6
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
4. Exploration and technology of earth environment	14,455	1.9	11,320	1.3	16,370	1.7	18,589	1.7
4.0 General research	-	-	-	-	-	-	-	-
4.1 Soil and subsoil	1,800	0.2	3,910	0.4	3,915	0.4	4,422	0.4
4.1.3 Mineral and petroleum prospecting	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
4.2 Seas and oceans	9,608	[illegible]	4,895	0.6	9,585	1.0	10,983	1.0
4.3 Atmosphere	3,047	0.4	2,515	0.3	2,870	0.3	3,184	0.3
4.3.3 Meteorology	(2,981)	(0.4)	(2,515)	(0.3)	(2,870)	(0.3)	(3,118)	(0.3)
4.9 Other research	-	-	-	-	-	-	-	-
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
5. Protection and promotion of human health	24,295	3.3	31,685	3.6	41,276	4.2	42,981	3.9
5.0 General research	17,217	2.3	17,633	2.0	25,020	2.6	23,835	2.2
5.1 Medical research	499	0.1	977	0.1	1,137	0.1	1,518	0.1
5.2 Research on food hygiene and nutrition	-	-	-	-	-	-	-	-
5.3 Research on environmental quality	382	0.1	369	0.1	330	-	297	-
5.3.1 Water pollution	(100)	(-)	(169)	(-)	(190)	(-)	(63)	(-)
5.3.2 Air pollution	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
5.3.3 Noise abatement	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
5.9 Other research	6,197	0.8	12,706	1.4	14,789	1.5	17,331	1.6

6.0 General research	2,985	0.4	3,538	0.4	3,527	0.4	4,023	0.4
6.1 Building construction and planning	6,049	0.8	7,178	0.8	9,632	1.0	11,302	1.0
6.1.1 Residential	(2,634)	(0.4)	(2,946)	(0.3)	(4,329)	(0.5)	(5,682)	(0.5)
6.1.2 Non residential	(1,164)	(0.2)	(1,532)	(0.2)	(1,656)	(0.2)	(1,770)	(0.2)
6.2 Civil engineering	5,105	0.7	8,263	0.9	9,702	1.0	10,911	1.0
6.3 Transport systems	3,970	0.5	3,114	0.4	4,169	0.4	6,985	0.6
6.4 Telecommunications systems	-	-	-	-	-	-	-	-
6.9 Other research	2,416	0.3	2,604	0.3	3,160	0.3	3,369	0.3
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
7. Promotion of agricultural productivity and technology	74,321	10.1	82,434	9.4	92,165	9.4	106,146	9.4
7.0 General research	41,640	5.7	46,030	5.2	51,093	5.2	60,695	5.5
7.1 Animal husbandry and wild life products	8,849	1.2	11,062	1.3	11,103	1.1	13,613	1.2
7.1.3 Veterinary medicine	(2,552)	(0.4)	(2,926)	(0.3)	(3,498)	(0.4)	(4,164)	(0.4)
7.2 Plant products (including forestry) and wines	17,456	2.4	19,397	2.2	23,568	2.4	23,201	2.1
7.3 Fishery and fish-farming products	2,475	0.3	1,520	0.2	1,709	0.2	1,969	0.2
7.9 Other research	3,901	0.5	4,395	0.5	4,680	0.5	4,460	0.4
(of which developing countries)	(-)	(-)	(455)	(-)	(2,722)	(0.3)	(3,991)	(0.3)
8. Promotion of industrial productivity and technology	60,295	8.2	69,876	8.0	65,656	6.7	66,250	5.9
8.0 General research	33,483	4.6	32,526	3.7	35,113	3.6	36,998	3.3
8.1 Products from non-nuclear energy industry	-	-	-	-				
8.2 Products from other industries	26,812	3.6	37,350	4.3	30,743	3.1	29,352	2.6
8.2.1 Chemicals	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
8.2.2 Metals	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
8.2.3 Electronics	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
8.2.4 Civil aviation	(21,081)	(2.8)	(22,139)	(2.5)	(12,512)	(1.3)	(14,263)	(1.3)
8.2.5 Other means of transport	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
8.2.9 Miscellaneous industries	(5,731)	(0.8)	(15,211)	(1.8)	(18,231)	(1.8)	(15,109)	(1.3)
8.9 Other research	-	-	-	-	-	-	-	-
(of which developing countries	(1,066)	(0.1)	(468)	(0.1)	(576)	(0.1)	(876)	(0.1)
9. Promotion of computer science and automation	-	-	-	-	3,980	0.4	5,650	0.5
9.0 General research	-	-	-	-	3,980	0.4	5,850	0.5
9.1 Hardware research	-	-	-	-	-	-	-	-
9.2 Software research	-	-	-	-	-	-	-	-
9.9 Other research	-	-	-	-	-	-	-	-
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
10. Promotion of research in the social sciences and humanities	29,931	4.1	29,826	3.4	36,066	3.7	46,200	4.1
10.0 General research	4,802	0.7	2,385	0.3	3,094	0.3	4,428	0.4
10.1 Research on education, training and retraining	8,045	1.1	8,743	1.0	11,226	1.2	15,382	1.4
10.1.1 In computer science	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
10.1.2 In industry	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
10.1.3 In agriculture	(275)	(0.1)	(300)	(-)	(350)	(-)	(475)	(-)
10.2 Business administration research	21	-	41	-	19	-	19	-
10.9 Other research	17,082	2.3	18,654	2.1	21,727	2.2	26,371	2.3
(of which developing countries)	(4,991)	(0.7)	(2,676)	(0.3)	(3,194)	(0.3)	(4,429)	(0.4)
11. General advancement of knowledge, n.e.s. (outside higher education)	35,463	4.8	41,298	4.7	51,387	5.2	54,495	4.9
11.0 General research	-	-	-	-	-	-	-	-
11.1 Research in the exact and natural sciences	32,256	4.4	36,981	4.2	46,472	4.7	48,720	4.4
11.1.0 General research	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
11.1.1 Natural sciences	(15,257)	(2.1)	(17,098)	(1.9)	(17,715)	(1.8)	(19,737)	(1.8)
11.1.2 Engineering	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
11.1.3 Medical sciences	(1,932)	(0.3)	(2,188)	(0.3)	(2,310)	(0.2)	(2,476)	(0.2)
11.1.4 Agricultural sciences	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
11.1.9 Other disciplines	(15,067)	(2.0)	(17,695)	(2.0)	(26,447)	(2.7)	(26,507)	(2.4)
11.2 Research in the social sciences and humanities	3,207	0.4	4,307	0.5	4,915	0.5	5,775	0.5
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
12. General advancement of knowledge, n.e.s. (inside higher education)	345,228	46.8	411,607	46.9	454,400	46.4	533,381	47.9
12.0 General research	-	-	-	-	-	-	-	-
12.1 Research in the exact and natural sciences	286,928	38.9	349,377	39.8	379,056	38.7	443,342	39.8
12.1.0 General research	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
12.1.1 Natural sciences	(99,500)	(13.5)	(128,697)	(14.7)	(146,656)	(15.0)	(174,731)	(15.7)
12.1.2 Engineering	(102,500)	(13.9)	(112,156)	(12.8)	(124,296)	(12.7)	(139,290)	(12.5)
12.1.3 Medical sciences	(65,600)	(8.9)	(80,397)	(9.1)	(77,133)	(7.9)	(92,067)	(8.3)
12.1.4 Agricultural sciences	(19,128)	(2.6)	(28,127)	(3.2)	(30,971)	(3.1)	(37,254)	(3.3)
12.1.9 Other disciplines	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
12.2 Research in the social sciences and humanities	58,300	7.9	62,230	7.1	75,344	7.7	90,039	8.1
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
For information: unclassified expenditure	-	-	-	-	-	-	5,219	0.5
(of which developing countries)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)
GRAND TOTAL	737,220	100.0	877,666	100.0	979,303	100.0	1,113,253	100.0
(of which developing countries)	(6,067)	(0.8)	(3,549)	(0.4)	(6,492)	(0.7)	(9,205)	(0.8)

NOTE: These figures are taken from the EEC Report on Public Financing of R and D expenditure. They were published before the provisional results of the 1969 survey were known. This explains why there are considerable differences, particularly with regard to University R and D, Pollution R and D and Agricultural R and D.

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Table 48. GOVERNMENT EXPENDITURE ON R AND D BY FIELDS OF APPROPRIATION AND MINISTRIES OF ORIGIN

1971 - BUDGET ESTIMATE

Million guilders

	TOTAL	EDUCATION AND SCIENCES	ECONOMIC AFFAIRS	AGRICULTURE AND FISHERIES	DEFENCE	SOCIAL AFFAIRS HEALTH	TRANSPORT WATER MANAGEMENT	CULTURE RECR. SOCIAL WELFARE	HOUSING AND PHYSICAL PLANNING	FOREIGN AFFAIRS	INTERIOR	JUSTICE	FINANCE	CABINET VICE-MINISTER PRESIDENT
Agriculture, fisheries	131.4	0.2	-	131.1	-	-	-	-	-	0.1	-	-	-	-
Industry, commerce ..	114.2	-	93.0	-	-	-	21.2	-	-	-	-	-	-	-
a) TNO Ind. Res. Org	(36.5)	-	(36.5)	-	-	-	-	-	-	-	-	-	-	-
b) Others	(77.7)	-	(56.6)	-	-	-	(21.2)	-	-	-	-	-	-	-
Science promotion ...	100.7	100.4	-	-	0.3	-	-	-	-	-	-	-	-	-
Nuclear energy	52.3	11.6	40.7	-	-	-	-	-	-	-	-	-	-	-
Defence	53.2	-	-	-	53.2	-	-	-	-	-	-	-	-	-
Health	60.4	2.3	-	-	-	58.1	-	-	-	-	-	-	-	-
Space research and Technology	45.2	22.1	21.7	-	-	-	1.4	-	-	-	-	-	-	-
Education	23.1	22.6	-	0.5	-	-	-	-	-	-	-	-	-	-
Water management ...	14.4	-	-	-	-	-	14.4	-	-	-	-	-	-	-
Arts and History	13.0	1.0	-	-	-	-	-	12.0	-	-	-	-	-	-
Housing	10.8	-	-	-	-	-	-	-	10.8	-	-	-	-	-
Development Aid	8.0	1.3	-	1.9	-	-	-	-	-	4.8	-	-	-	-
Traffic and Transport .	8.1	-	-	-	-	-	8.1	-	-	-	-	-	-	-
Social Development, insurance	6.1	-	-	-	-	2.0	-	4.1	-	-	-	-	-	-
Physical planning	2.7	-	-	-	-	-	-	-	2.7	-	-	-	-	-
Justice and Police ...	2.2	-	-	-	-	-	-	-	-	-	1.1	1.1	-	-
Other non-class. items	17.1	2.2	5.5	0.1	-	0.2	3.4	2.2	-	0.8	2.5	-	0.1	0.1
Sub-total	652.9	163.7	160.9	133.6	53.5	60.3	49.5	18.3	13.5	5.7	3.6	1.1	0.1	0.1
Multi-departmental ST inf., computer sciences	7.1	4.6	2.5	-	-	-	-	-	-	-	-	-	-	-
Sub-total	670.0	168.3	163.4	133.6	53.5	60.3	49.5	18.3	13.5	5.7	3.6	1.1	0.1	0.1
R and D Policy funds..	7.5	7.5	-	-	-	-	-	-	-	-	-	-	-	-
Sub-total	677.5	175.8	163.4	133.6	53.5	60.3	49.5	18.3	13.5	5.7	3.6	1.1	0.1	0.1
Higher Education	529.1	497.5	-	31.6	-	-	-	-	-	-	-	-	-	-
TOTAL	1,206.6	672.3	163.4	165.2	53.5	60.3	49.5	18.3	13.5	5.7	3.6	1.1	0.1	0.1

SOURCE: Ministry of Education and Sciences.

fields of appropriation in rows and ministries in which the funds originate in columns.

When the higher education sector is excepted as a specific case (which is examined as a sector on its own in Part Five) this table can be rearranged by order of magnitude of field of appropriation and subsequently by contributing ministries (Table 48).

According to this classification, expenditure on R and D in agriculture and fisheries ranks first, followed by funds allocated to industry and commerce and by expenditure devoted to promotion of science outside the higher education sector.

A group of medium-sized fields of appropriation includes nuclear energy, defence, health, space research and technology.

Still smaller amounts are devoted to such purposes as education, water management, arts and history, housing. Finally, relatively modest sums are allotted to remaining purposes, among which are development aid, traffic and transport, social development and insurance, physical planning, justice and police and other non-classified items.

With the exception of industry and commerce, nuclear energy, space research and technology, specific purposes can be largely identified with respective ministries so that purpose and operational level overlap leaving the policy-maker with the traditional scheme of particular ministerial responsibility.

II

GOVERNMENT R AND D FUNDS BY MAJOR "PURPOSE"

There is no doubt however that the functional breakdown of government expenditure on R and D will be further refined and deepened both as an analytical tool and a decision making instrument in the field of science policy.

Hereafter, the main fields of appropriation will be examined in some detail. To facilitate the analysis, they are grouped by basic concern:

1. Economic development: Agriculture, Fisheries, Trade and Industry, Traffic and Transport.
2. Environmental Development: Water Management, Housing and Physical Planning.
3. Social Development: Health, Social Development and Insurance, Justice and Police.
4. Promotion of Science and Knowledge: Promotion of Sciences, Education, Arts and History.
5. Big Science: Nuclear Energy, Space Research and Technology.
6. Defence.
7. Other fields.

1. ECONOMIC DEVELOPMENT

a) Agriculture, forestry and fisheries

The total annual budget of all R and D activities under the Ministry of Agriculture and Fisheries amounts to approximately 10% of the overall budget of this ministry. The budget estimate for appropriations in this field amounted to 128.9 million guilders in 1971.

The entire research programme comprises about 2,000 research projects. The personnel employed in R and D activities numbered 2,970 persons in 1970 of which about a sixth were scientists and engineers.

The Central Organisation for Applied Scientific Research TNO employed approximately 450 persons in 1970.

Furthermore, both the Agricultural University at Wageningen and the Veterinary Faculty of the University of Utrecht are engaged in R and D activities. According to a rough estimate the number of staff employed in research activities can put at 490 in the first case and 180 in the second.

A breakdown of total expenditure on agricultural R and D by discipline is given in Table 50. For most of the disciplines, there seems to be a regular incremental development. From now on high priority is given to research in connection with general valorisation of agricultural produce and marketing, i.e. the complete chain of processing and improvement from harvested produce to consumer.

The results of agricultural R and D are of interest not only to agriculture but also to several other areas of application such as physical planning, foodstuff industry, machine industry, protection of public health, pollution, development aid, etc.

R and D in connection with problems of pollution is particularly urgent and an increasing part of agricultural research is directed to this end. Special attention is being paid to an increase in R and D potential concerning the pollution of water, air and soil by agricultural and horticultural holdings as well as by industries involved in the processing of agricultural produce.

As shown in Table 51 the abatement of pollution in the earth environment is receiving increased attention, particularly as far as the use of biocides is concerned. The improvement of the environment for health and recreation purposes accounts for an important amount of R and D funds devoted to agriculture and its impact on nature and, finally, on man.

Agricultural R and D is also becoming an important instrument in the aid to developing countries. Arrangements were made with several institutes to promote research concerning the improvement of all aspects of agriculture in less-developed regions. This does not imply the

Table 49. STAFF AND EXPENDITURE IN INSTITUTIONS FOR AGRICULTURAL AND FISHERY R AND D

YEAR	STAFF			EXPENDITURE IN THOUSAND GUILDERS	
	SCIENTISTS AND ENGINEERS	OTHER PERSONNEL	TOTAL	PERSONNEL	PERSONNEL AND EQUIPMENT
INSTITUTIONS FOR AGRICULTURAL R AND D					
1966	512	2,471	2,983	48,127	68,639
1967	514	2,483	2,997	53,690	76,522
1968	528	2,365	2,893	57,747	82,992
1969	516	2,377	2,893	64,334	91,740
1970	516	2,395	2,911	-	-
INSTITUTIONS FOR FISHERY R AND D					
1966	12	37	49		1,210
1967	13	41	54		1,416
1968	13	42	55		1,776
1969	14	50	64		2,149
1970	14	44	58		-

SOURCE: Ministry of Agriculture and Fisheries.

stimulation of research in the Netherlands only but also in countries particularly concerned by the offer of assistance in research, education and establishment of new forms of cooperation on the spot.

In its first advisory report to the Government, the Science Policy Council recommended a slowing-down of the growth rate of expenditure on agricultural R and D and thus a relative decrease in the longer run. This analysis was based on consideration of the decreasing relative importance of agriculture both in the gross national product and civilian employment.

However, new interdepartmental measures for achieving better coordination and organisation of scientific research in the field of environmental quality were taken recently. Considering the excellent organisation of scientific research sponsored by the Ministry of Agriculture and Fisheries, the Science Policy Council is now of the opinion that the agricultural research institutes can perform well-defined tasks on the management of environment. This is expected to be realised by gradual shifts of emphasis within agricultural R and D, which will undoubtedly raise new problems of coordination between agricultural research institutions and other ministerial departments.

b) Trade and industry

In its analysis of industrial R and D the Science Policy Council made an assessment of research intensity by size of firms. Netherlands industrial life is dominated by the so-called "big five", corporations with multinational ramifications, which account for about the two-thirds of total expenditure on R and D in industry.

As far as the remaining share is concerned, the situation differs considerably between big firms and smaller ones. In the group of big firms - other than the big five - the size and level of R and D expenditure are increasing. However, this development does not seem to be always sufficient to meet pressure from competition and the requirements of rapid innovation. As to the various categories of medium and small-sized firms, R and D activities are in general barely adequate.

As is shown in Table 48 a good third of R and D expenditure devoted to trade and industry is directed towards the Organisation for Industrial Research TNO. The Science Policy Council considers that this organisation performs useful work in several sectors and in particular in the fields of fundamental research, control and evaluation. However, the structure and the working methods of the Organisation seem to be less effective where process research and development are concerned.

Table 50. EXPENDITURE ON AGRICULTURAL R AND D BY DISCIPLINE

Thousand guilders

FIELDS OF RESEARCH	1967	1968	1969
Soil management, fertilization, land and water management ...	12,322	13,561	14,118
Management of recreational and wild life resources, forests ...	560	616	535
Crop husbandry	7,378	8,573	8,614
Plant breeding	9,642	10,195	11,658
Plant protection and weed control	7,844	8,440	9,394
Animal husbandry	1,401	1,352	2,225
Animal feeding	2,839	2,587	3,074
Animal breeding	2,468	2,625	1,960
Veterinary surgery	2,960	2,991	4,224
Agricultural engineering (buildings, machinery)	5,327	5,792	6,585
Storing and processing	6,403	6,299	6,367
Home management	1,144	1,148	1,233
Farm- and work management, marketing	7,302	7,735	8,467
Rural planning	2,306	2,478	2,874
Various	2,126	2,403	2,553
Total for research	72,022	76,795	83,890
Services	18,614	20,405	21,050
General Total	90,636	97,200	104,940

SOURCE: Ministry of Agriculture and Fisheries.

Table 51. EXPENDITURE ON AGRICULTURAL R AND D ALSO OF INTEREST TO THE MAINTENANCE AND IMPROVEMENT OF LIVING CONDITIONS

Thousand guilders

	1967	1968	1969
a. Moderation of the pollution of human environment as a result of:			
1. The use of biocides	3,812	4,479	5,554
2. Soil decomposition resulting from transportation, flooding, desiccation	748	868	1,000
3. Oversalting, salt water	285	329	342
4. Radio-active matter	1,024	1,088	1,006
5. Mineral, vegetable and animal refuse including foul smell	1,418	1,514	1,738
6. Animal diseases contagious to man	150	144	190
7. Foodstuff and cattlefeed-pollution through chemicals or micro-organisms	1,487	1,606	1,788
8. Thermal pollution and noise-nuisance	-	-	5
Total	8,924	10,028	11,623
b. Enrichment of human environment through:			
1. Maintenance and development of forests, nature and recreation areas important to human environment	3,225	3,731	4,037
2. Maintenance of animal species required by mankind	527	595	637
3. Promoting the appropriate use of the soil	2,760	3,062	2,819
4. Promoting the cultivation of ornamentals	5,087	5,612	6,127
5. Effective organisation and classification of living quarters, as well as education of the rural population	1,895	1,947	1,938
Total	13,494	14,947	15,558
General total	22,418	24,975	27,181
Total expenditure on R and D in agriculture	90,636	97,200	104,940

SOURCE: Ministry of Agriculture and Fisheries.

The Science Policy Council is of the opinion that R and D activities in the sector of industry and economy can be executed effectively only in the respective industries or at least in closer cooperation with TNO than is the case at the moment.

In its progress report for 1970 the Science Policy Council stressed "the lack of a clear, specific policy in the Netherlands for industrial expansion in a comprehensive general setting". This is to be interpreted as a basic understanding of the innovative process in all sectors of society, which involves both industrial growth and new openings for the application of technology. Such a policy is needed in order to tackle simultaneously the problems of relevance of R and D activities for economic growth, industrial structure and size pattern of business firms.

The Science Policy Council repeatedly insisted on an increase of funds for the development of technical processes, equipment and new products. This could be achieved partly by shifts in expenditure items, for instance by decreasing expenditure in the fields that are already undergoing considerable expansion and appear as maturing branches of R and D, such as nuclear energy.

Finally, it is recommended that more resources be devoted to research of an economic structural nature so that the impact of R and D on the economic system and in particular on changes in the industrial pattern may be better understood.

c) Traffic and transport

R and D funds in the field of traffic and transport increased rapidly during the years 1967-1971. In spite of this the total amount devoted to this sector remains fairly modest. In 1971 the budget estimate was 6.9 million guilders, about 0.5% of government expenditure on R and D or slightly more than 1% of the science budget, excluding higher education.

Given the size and nature of traffic and transport problems, this effort is still far from sufficient. These problems should be tackled in a broader frame implying in particular the formation and intensive use of multi-disciplinary teams of experts.

Up to the present, physical planning research has been directed to missions and problems closely connected with regional and urban planning without satisfactory incorporation of transport planning. Serious difficulties arise as to the integration of transport into this broader concept as long as the starting points and the basic objectives of physical planning are not clearly defined and fitted, in their turn, into a general programming of social development.

The Netherlands Economic Institute in Rotterdam is in charge of an investigation on traffic flows and the corresponding rail- and road-infrastructure for the next decades; this study is in its final stage. A study on stimulation of public transport in the Western part of the country is also in its final stage.

2. ENVIRONMENTAL DEVELOPMENT

a) Water management

Considering the topology and the relative importance of reclaimed land in the Netherlands it is easily understandable that water management is one of the basic national concerns. R and D expenditure in this field rose rapidly during the years 1964-1968 with an average annual increase of 33%. In the 1971 science budget, 13.8 million guilders were earmarked for this purpose, that is about 1.1% of total government expenditure on R and D.

Endeavours are being made to concentrate and coordinate R and D effort in this domain. The major part of R and D activities is carried out in connection with the executive phase of projects of water and flood control.

It is expected, however, that a greater part of this research could also be of interest in other fields and in particular in environmental problems, over the entire spectrum of water, air and soil management.

b) Housing

In the 1971 science budget 10.8 million guilders were allocated to R and D activities in the area of housing and building. This amounted to about 0.8% of total government expenditure on R and D. Though available resources have been practically doubled, this sum may still be considered as fairly modest.

R and D in the field of building and socio-scientific research aimed at improvement of dwelling conditions and urbanisation in general are considered to be an indispensable part of any modernisation and true progress in this sector.

The Ministry of Housing and Physical Planning backed the initiative tending to submit the whole sector to a thorough investigation of all

R and D possibilities. This led to the creation of a special pilot committee for investigation of R and D whose task it is to study the scope and size of the R and D effort in the sector as well as the state of the art and possible future needs and tendencies.

In the beginning of 1971 the committee concluded in a report that a certain number of improvements, a.o. regarding the organisation and co-ordination of R and D in the building sector are necessary, although the level of these activities generally does not lag behind that in other European countries. For that reason the committee advises the creation of a small master organisation in order to advise the authorities and the other parties involved on an integrated and long term policy for R and D in the building industry. This policy-advisory team should preferably be composed of a small group of leading officials who are elected in this committee "à titre personnel". If this team consists of members who have sufficient authority in the building industry sector, it is indeed to be expected that it will only be an exception that advice given by them is not put into practice. The Minister of Housing and Physical Planning has taken the initiative for the creation of such a co-ordinating body.

As this pilot committee has been proved useful the Government intends to extend this practice and this form of investigation to other sectors in order to get a more comprehensive picture of their prospects and potential needs. The entrepreneurs of the building industry have insisted upon the establishment of an investigation into the structures of the building industry. The Ministers of Housing and Physical Planning and of Economic Affairs are prepared to promote such an investigation, also financially, as much as possible.

c) Physical planning

Basically, the term physical planning covers problems of regional and urban planning in the broadest sense.

In its first advisory report, the Science Policy Council had insisted on the need of a triplication of R and D expenditure in the field of physical planning during the period 1969-1971, in comparison with 1.6 million guilders allocated to it in 1967. However the actual figures remained far from this target. In the 1971 budget estimate, only 2.7 million guilders were allotted for this purpose.

In view of the density of the population, the geographical position of the Netherlands and the necessity of incessant structural adaptativeness of the national economy, the Science Policy Council is of the opinion that R and D activities in this area should be given the highest priority.

Lack of manpower and the prospects of having recourse to foreign experts should not hamper increasing efforts in this field. What is needed is a balanced analysis of the problems continuum, the research methods and exploratory techniques. According to the advice of the Science Policy Council, not the funds but the level of the research must fix a limit to these R and D activities.

So far the scientific research in the area of physical planning is insufficent and scattered over too many institutions. The Physical Planning Service is called upon to undertake a survey of all R and D activities in this area both inside and outside the Ministry of Housing and Physical Planning. This appears as a first step to a meaningful co-ordination of R and D efforts and to sustained support by the Government of new research in this sector.

d) Concept of terrestrial environment

To complete the picture of R and D effort in the area of environmental development, some information can be added on the work connected with the redefined concept of terrestrial environment.

In 1970 about 18.6 million guilders were devoted to investigations in this area and namely to three major fields:

i) earth sciences;

ii) sea research and oceanography;

iii) research of the atmosphere and meteorology.

i) Earth sciences

Government expenditure on R and D in the earth sciences shows a continuous and regular progression. These activities are mainly carried out in the universities and by the Geological Survey of the Netherlands, a public institute which reports to the Ministry of Economic Affairs on geological matters, especially those related to exploration and extraction of minerals.

Research in earth sciences is carried out at the universities of Utrecht, Amsterdam, Leiden and Groningen (geology, marine geophysics, palaeomagnetism) and at the Royal Netherlands Meteorological Institute (seismology, geomagnetism).

The Organisation ZWO sponsors the Laboratory for Isotope Geology (IGO).

The Ministry of Agriculture and Fisheries sponsors a research foundation responsible for agro-geological surveys of the Netherlands.

A few years ago this foundation started to make a systematic investigation of the topographical structure of the country. Together with the Geological Survey the foundation is responsible for preparing a geomorphological map of the Netherlands.

ii) Sea research and oceanography

Government support in this field amounted in 1970 to more than 9.5 million guilders of which about 8 million guilders were allocated to the Netherlands Institute for Sea Research. About a half million guilders was attributed to the Royal Navy's Hydrological Service whilst ZWO and the Royal Netherlands Meteorological Institute also support oceanographic activities.

Government responsibilities in this area are divided among several ministerial departments. As the study of oceanography is rapidly gaining in importance, the Council of Ministers have decided to create an Interdepartmental Committee for Oceanography whose main tasks are:

- to advise the responsible ministers in this field;
- to promote optimal division of tasks within the national and international oceanographic programmes;
- to prepare the annual programme for an oceanographic research vessel to be constructed.

On the scientific level the Government is advised by the Netherlands Commission for Sea Research of the Royal Netherlands Academy of Sciences.

Sea research and oceanographic projects are carried out in a number of governmental and semi-governmental institutes and laboratories.

In the governmental sphere three groups of institutes are engaged in oceanography:

a) Institutes for fundamental sea research. The leading institute in this field is the Netherlands Institute for Sea Research on the Isle of Texel which closely co-operates with all relevant university institutes.

Fundamental research of the sea is also performed at the Delta Institute for Hydrobiological Research at Yierseke, an institute of the Royal Academy of Sciences. This institute deals more particularly with ecological problems connected with the closing of the Rhine-Meuse delta.

b) Institutes carrying out sea research primarily directed toward general applications. The Royal Netherlands Meteorological Institute performs an oceanographic research programme on certain basic aspects in this field which are of interest in its meteorological research. On the whole 30 persons, of whom about a half of scientists, are engaged in this programme.

At the Organisation TNO several working groups are studying corrosion problems. Furthermore, the Technical Physical Service TNO - University of Delft is specialised in the development and construction of measuring instruments for sea research.

c) Institutes carrying out research of the sea as a secondary objective. The most important government services in this category are the following:

- The Department of public Waterworks with many divisions and study groups, mainly engaged in research activities concerning coastal engineering and water pollution;
- The Hydrography Division of the Royal Navy performs oceanographic research, mainly in connection with the sea bed;
- The State Institute for Fishery Research of the Ministry of Agriculture and Fisheries performs observations concerning fish as well as other phenomena such as sea water temperature, etc.

iii) Research of the atmosphere and meteorology

The Royal Netherlands Meteorological Institute performs practically all meteorological research in the Netherlands. The research activities of the Institute are mainly directed to practice implications and can be divided into the following categories:

- Macro-meteorological research aimed at the:
  - improvement of general forecasting of weather and water level by adequate modelling with the aid of computers;
  - extension of the forecasting periods;
  - understanding of certain kinds of hydrological problems and climatological fluctuations of more than one year.

- Meso-meteorological research concerned mainly with the problems of air pollution and predictability of the circumstances in which danger from air pollution threatens, and with the study of changes in the climate of the Netherlands as a result of man-made interventions.

- Micro-meteorological research bears on the study of fog and on investigation of micro-climates as a contribution to the abatement of plant diseases and pests.

3. SOCIAL DEVELOPMENT

a) Health and related aspects of human environment

The policy of the Government in the field of R and D on human health and related aspects of human environment aims particularly at a good balance between fundamental research and operational technology. There is a lag in the development of operational technology development, at least in comparison with industrial development activities. This lag seems to be mainly manifest in regard to prevention of diseases and health promotion in general.

In order to achieve this goal, the Government favours a multidisciplinary integrated R and D policy, as it is aware that a common effort by all interested parties is needed, bringing together industrial laboratories, government institutes and university research centres. To promote a co-ordinated approach to these problems a common study and information centre TNO for environmental research was created under the responsibility of all relevant policy bodies and with the co-operation of the main research institutes in this field.

In its first general advisory report the Science Policy Council emphasised the great importance of scientific research in the field of public health. The expense level at that time was considered to be rather low, but nevertheless an "average rate" of increase was advised because, to begin with, a thorough re-organisation of university research and coordination of university and non-university research was deemed necessary. Later on the Council advised an augmentation of the annual increase.

Since 1964 the increase in expenditure on health research by the Ministry of Social Affairs and Health has been sustained. In the 1971 budget estimate almost 50 million guilders were allocated for this purpose, for the first time almost as much as for defence research or nuclear research. When considering this increase it must be taken into account that health research requires a strongly increasing multidisciplinary approach which necessitates an even more expensive apparatus.

The Council for Health Research TNO and the Medical Scientific Research Council sponsored by the Royal Netherlands Academy of Sciences, both established recently, face an important task and heavy responsibility, particularly in the field of co-ordination of the medical research effort. They will have to deal with an extremely complex organisation of medical research in which there participate - to name only the most important institutions - the universities, the Organisation for

Health Research TNO, the Organisation for the Advancement of Pure Research ZWO (via the Foundation of Fundamental Medical Research (FUNGO) and the Ministry of Social Affairs and Health.

The Science Policy Council recommends a rise in the increase of expenditure for scientific research in the field of health also with a view to enabling the Ministry of Social Affairs and Health to launch projects of heart and vascular diseases. In its opinion pluri-annual planning is particularly desirable in this field if a high degree of co-ordination is to be achieved.

b) Social development and insurance

The sum allocated to this purpose rose from 3.7 million guilders in 1967 to 6.1 million guilders in the budget estimate for 1971. This is relatively a small amount, representing less than one-half per cent of total government expenditure on R and D.

According to the Science Policy Council an increase of efforts in this field is necessary, but it should be closely linked to improved organisation of research.

The Science Policy Council is further of the opinion that Government policy should be based on a somewhat quantified model of what is generally understood by the "welfare of the population". The social sciences, however, are still looking for parameters which are relevant in this matter. It is necessary to stimulate this kind of research and to remove financial impediments, provided that needs are agreed upon.

c) Justice and police

Expenditure for this purpose amounted to 2.2 million guilders in the 1971 budget estimate. This is the smallest item in government expenditure on R and D by main functional category.

Scientific research in this field is directed, on one side, at the legal order in general and, on the other, at specific problems faced by the judicial and police apparatus. This is a consequence of the growing density of human settlements and agglomerations and resulting tensions. However, it is considered that the stimulation of this kind of R and D is a matter of organisation rather than of money.

d) General perspective of social sciences

A majority of projects in the field of social sciences, both those carried out in the university and in other research institutes, are of an applied nature. Non-university research is mainly carried out under the responsibility of three Ministries: Ministry of Cultural Affairs, Recreation and Social Welfare, Ministry of Social Affairs and Health and Ministry of Education and Sciences.

Because of the rapid growth of the different social sciences in the Netherlands, research in this area has been spread over a large number of organisations: one can even speak of a certain splitting up of research activities.

Social sciences are in principle covered by the Social Science Council of the Royal Academy of Sciences and Letters, created in 1959. This Council may be seen as a central advisory body in the field of research in social sciences. It has, however, no direct institutional links with scientific institutes or government agencies and not every problem of social science research or training is brought to its attention.

The main tasks of the Social Science Council are :

- to give advice to, and through, the Academy on matters concerning social sciences;
- to stimulate and co-ordinate social science research in special, often-neglected areas.

The Council supervises the activities of the Centre for Social Science, Documentation and Information, which provides since 1964 for the publication of the "Register of current research in the social sciences in the Netherlands", a "Bibliography of projects achieved" and a "List of doctoral theses".

At the request of ZWO, the Social Science Council created in 1969 a study group to develop an overall programme of social science research and thus contribute to an improvement in the allocation of manpower and financial resources in this area.

For some branches of social sciences there are special co-ordinating organisations, for example, the Foundation Inter-university Institute for Social Science Research (SISWO), which is an organ for the co-operation of sociological, socio-geographical and regional planning university institutes, and the Netherlands Inter-university Demographical Institute (NIDI), which co-ordinates demographical research.

Several other institutions working in other fields of social science research may be mentioned. The State Psychological Office is charged, among other things, with the tasks of advising the Minister of Interior in the socio-psychological and psycho-diagnostic field and to carry out research in the respective areas.

The Inter-university Institute for Social Science Research deals with more fundamental research problems. It also co-ordinates the activities of the sociological departments of the universities. This institute is responsible for managing a series of monographs and social science studies based on the period 1971-1975 which are expected to be a useful contribution to the understanding of the Netherlands society in the 1970s.

The Government decided in 1970 to give its full support to an independent non-government National Institute for Peace Research which will make use of those scientific developments that contribute to the study of these problems. This institute will carry out studies on current trends as well as provide information for educational and other purposes to all institutions and organisations concerned both inside and outside the Government.

Social welfare activities are stimulated by the Ministry of Cultural Affairs, Recreation and Social Welfare. Special divisions for research coordinate the research activities sponsored and initiated by this Ministry. A number of specialised institutes for research in the field of social work, social welfare and community development are subsidised by the Ministry. Studies can be initiated by the Ministry itself, in which case government officials have to translate the results into operational objectives. Studies can also be initiated outside the Government sphere by the researchers themselves. If the aims of the proposed study correspond with the view of the Ministry the latter may support the study financially.

During its short history this Ministry structured its research activities to an increasing degree. The ad hoc studies carried out by freelance researchers in the initial period are now replaced by long-term investigations by research teams. Furthermore, a start has been made with research on the evaluation of policy instruments in the field of social welfare.

The Ministry of Social Affairs finances wholly or in part research in the following areas:

- work and leisure time, labour supply and demand, labour structures and relationships, social security, special social groups.

Within the framework of the promotion of productivity the Ministry of Economic Affairs has, since about 1950, financed wholly or in part research particularly aimed at subjects like social integration within industry (participation, communication, etc.), shiftwork, renewal of job structures etc. Before financial support is granted the Netherlands Productivity Centre gives its advice on these projects to the Ministry of Economic Affairs. In relevant cases research in these fields is financed by the Ministry of Economic Affairs together with the Ministry of Social Affairs.

As a rule this Ministry does not itself carry out research but through scientific institutions. The procedure adopted may be described as follows:

1. The problems and, in some cases, the overall research plans are formulated by the Scientific Department of the Ministry.
2. A scientific institute then carries out the field-work assisted by a committee of experts acting in an advisory capacity.
3. Where necessary, the Scientific Department "translates" the results of the research project for the benefit of the decision-makers.

4. PROMOTION OF SCIENCES AND KNOWLEDGE

a) Promotion of scientific activities outside the universities

This functional category comprises mainly the budget of the Netherlands Organisation for the Advancement of Pure Research ZWO and the financing of the scientific institutes of the Royal Academy of Sciences. It also includes subsidies for the scientific programme of NATO, the contribution to the European Conference on Molecular Biology and the European Southern Hemisphere Observatory, subsidies for a participation in a few projects in other countries and grants to the Netherlands Central institute for Brain Research.

i) The Netherlands Organisation for the Advancement of Pure Research - ZWO

The ZWO extends financial aid in two main ways:

- contributions to specific projects of individual scientists or scientific institutes;
- subsidies to research institutions.

The first form of aid is often of a supplementary nature. It may be granted to encourage valuable initiative or a promising new line of research in cases where the university is unable to make provisions in its budget. Another possibility is to grant special aid when a concentration of funds and staff on a certain project is needed. A body like ZWO is a far more suitable agent for distributing financial aid than a government agency or even a board of governors of a university would be.

Among the research institutes financed by ZWO, the Foundation for Fundamental Research on Matter (FOM) is by far the most important and accounts for more than a half of the whole ZWO's expenditure. Other bodies which receive substantial contributions are the Foundation for Radioastronomy, the Foundation for Chemical Research (SON), the Foundation for Biophysics and the Mathematical Centre, to mention only the most important.

The financial support given by ZWO during the period 1966-1969 can be broken down by scientific field, as shown in Table 52.

As early as 1967 the Science Policy Council recommended that increased subsidies should be granted for research in the fields of humanities and the social sciences and for fundamental research in the fields of mathematics, chemistry, biology and medicine, provided that these subsidies were spent on high-level projects.

This advice was welcomed by the Board of ZWO which is of the opinion that a larger part of basic research should be funded through specialised scientific advisory panels.

A possible increase will not be realised by diminishing the size of funds in the general financial scheme of the universities as the universities are already under heavy stress as a result of a continuous growth in student numbers and for consequent need for innovation in the educational system.

ii) The Institutes of the Royal Academy of Sciences and Letters

The Academy of Sciences has, among others, the task of stimulating scientific research activities which can only be carried out by co-operation between scientists and with government support. This task is accomplished through a number of the Academy's own research institutes.

- Institute of Ecological Research, carrying out and promoting ecological research in its widest sense in several laboratories spread over the country and cooperating with other organisations in this field.
- Limnological Institute, which is a research centre for basic biological, chemical and hydrological research of inland waters and at the same time an educational institute for hydro-biologists.
- Delta Institute for Hydro-biological Research, which has the task of studying biological changes due to the reclamation of the Sealand waters.
- Foundation Central Office for Mildew Cultures, which is promoting mycological research and co-operating with other organisations in this area.

Table 52. ZWO SUPPORT FOR SCIENTIFIC ACTIVITIES

1966 - 1969

	1966		1967		1968		1969	
	THOUSAND GUILDERS	%	THOUSAND GUILDERS	%	THOUSAND GUILDERS	%	THOUSAND GUILDERS	%
Humanities	1,648	4,0	1,927	4,3	1,773	3,5	1,388	2.9
Social sciences	1,622	4,1	1,441	3,2	1,823	3,6	2,449	4.4
Exact sciences	32,148	81,1	36,339	81,3	41,247	81.1	43,964	79.5
of which:								
mathematics	2,088	5,2	1,581	3,5	1,654	3,2	1,956	3.5
physics	20,[illegible]22	52,7	22,488	50,4	26,570	52.3	27,718	50.1
chemics	4,129	10,4	6,002	13,4	5,678	11.2	6,373	11.5
astronomy	4,235	10,7	5,285	11,8	6,084	12.0	6,499	11.7
geology	861	2,1	938	2,1	1,177	2.3	1,380	2.5
Life sciences	4,153	10,5	4,964	11,1	5,969	4.7	7,251	15.1
of which:								
biology	2,262	5,7	2,848	6,4	3,142	6,2	4,086	7.4
medicine	1,891	4,8	2,1[illegible]6	4,7	2,827	5.5	3,165	5.7
Other areas	35	0,1	18	0,04	13	0,03	17	0.03
TOTAL	39,606	100,0	44,689	100,0	50,825	100,0	55,279	100,0

SOURCE: ZWO.

- Embryological Institute, carrying out research in the field of development biology.
- Central Committee on research of dialects, folklore and onomastics.

Furthermore, the Academy of Sciences has an important say in the management of the Netherlands Central Institute for Brain Research, where brain research is carried out from different points of view, morphological, neurophysiological and neurochemical.

b) Education

In the 1971 budget estimate almost 22 million guilders were earmarked for this purpose. Research activities in this area, carried out with government support, are almost entirely applied to innovation of the educational system. Such innovation appears necessary because of requirements in a quickly-changing society, consequences of new educational technology and problems arising from the democratisation of education.

Since 1965 the research activities directly sponsored by the Ministry of Education and Sciences are co-ordinated by the Foundation for Education Research which channels the subsidies of the ministry devoted to the education research. As an advisory organ, the Foundation contributes to a better instrumentation of education research, namely by favouring the expansion of research facilities. It also pays attention to the study of methods in three pedagogical centres and to the transfer of knowledge between different levels of the educational system. Co-ordination of research activities on university education is also furthered by the Central Bureau for Research of University Education, established by the Netherlands Universities Council in 1964.

The Science Policy Council pointed out, in its first advisory report, that the methods used in the educational system were inadequate compared with educational practice in other countries. Without extensive research into teaching methods and the social functions of education, adequate reforms will be impossible.

The Science Policy Council also holds the view that there should be multi-disciplinary teams to treat the complex problems in this field. In the meantime it strongly recommends the establishment of a pilot committee which should not only pay attention to the progress of research in the field of methodology and didactics, but also to some very divergent aspects of educational policy, such as the extent to which:

- experts in each relevant field of science should be contacted in preparing new programmes and methods;

- attention should be given to the social function of the scientific discipline in the preparatory phase;
- mechanism for introduction and functioning of improved methods is available;
- programmes of the various educational institutions are tested against changing circumstances.

This advice in the first instance was received with hesitation by the Government. Recently it has been decided in principle to establish a pilot committee for the field of educational research.

c) Arts and history

In the 1971 budget estimate 12.4 million guilders were allotted to arts and history research, that is about 1% of government expenditure on R and D. This item mainly concerns research done by state institutions, such as museums.

In a broader perspective, a Committee on Humanities was established in 1961 by the Minister of Education, Arts and Sciences. It was charged with the task of making a study of the state of the art in this area proposing a coherent frame of criteria necessary for a balanced policy regarding training as well as research in humanities, in particular in the universities where almost all this research is carried out, partly with the aid of ZWO.

In its report, published in 1964, the Committee formulated two fundamental functions: 1) the promotion of knowledge and understanding; 2) direct transfer of cultural achievements - and seven derivated functions of the humanities. To enable scientists to carry out these functions, particular care must be taken in selecting and training them. At the same time closer co-operation between scientists of the various universities is urgently needed.

On the basis of this report, the Committee set up a number of recommendations, e.g. the creation of an advisory body to the Government as an intermediary for subsidising the activities of non-university research institutes in the area of humanities. This body should allocate government subsidies taking into account the scientific level of the institute and the quality of projects.

Furthermore, the Committee advocated the establishment of a Central Translation Institute for the universities and took over the idea of a Centre for Advanced Studies based on the model of the Centre for Advanced Study for the Behavioral Sciences, Stanford College, California. In their comment on the report of this Committee the universities endorsed many of its recommendations.

In its interim advice the Science Policy Council recommends a relative increase in governmental support of the humanities, as cultural ethical aspects of society deserve special attention to compensate for the growing pressure of technology and economic growth as well as of new problems created by increasing leisure. Recently the Council proposed a considerable increase in the grant to ZWO; this money should be applied to promotion in the fields of humanities and social sciences.

In 1971 the Netherlands Institute for Advanced Study opened its doors in Wassenaar. During the period of an academic year 25 Netherlands scientists and 15 foreign scientists are enabled to do only research activities within a particular framework.

5. "BIG" SCIENCE

a) Nuclear energy

In the 1971 budget estimate 52.2 million guilders were allotted to nuclear research, that is, about 4.1% of total government expenditure on R and D. Nuclear research continues to be an important topic though the rate of funds devoted to it has been slowed down considerably during these last years. These funds now aim more and more at applied research and technological development.

They are attributed mainly to the Netherlands Reactor Centre on the one hand and the international organisations Euratom and CERN on the other.

The Reactor Centre of the Netherlands was founded in 1955 by the Government, the electricity utilities, a number of firms and the Foundation for Fundamental Research on Matter. Under the auspices of the latter, nuclear energy work in the Netherlands has been initiated. These four participating bodies are represented on the governing body of the Centre.

There are three research reactors on the site of the Centre at Petten, one of which, the High Flux Reactor, is the property of Euratom and forms a part of the research establishment of that organisation which adjoins the Centre's site. This reactor is operated by the Centre under contract with Euratom.

Much of the Reactor Centre work now concerns fast-breeder technology and is carried out in close co-operation with the nuclear centres in Karlsruhe and Mol. The Centre also co-operates with the Institutt for Atomenergi in Norway and the Norwegian Reactor School at Kjeller.

As a participant in the OECD Halden Project, the Reactor Centre irradiates two assemblies of vibratory compact fuel. Other contacts with OECD are those with the Dragon Project and the participation in the ENEA working group on gas-cooled fast reactors. An ad hoc Committee, established at the end of 1970, with the president of the Science Policy Council as chairman, reviewed the RCN-programme. The Committee judged the programme generally well balanced and in conformance with the requirements for the country's main institute for research and development of nuclear energy. The Committee recommended strengthening the links with industry.

It has also been the policy of the Government since 1962 to give direct subsidies to industrial development projects in the field of nuclear energy. With this aid more than 90% of the 50 MWe nuclear power plant at Dodewaard was built by Netherlands industries. These funds are now mainly used to finance industrial development work on gas centrifuges and on components for sodium-cooled fast reactors.

Some doubts have been expressed as to the justification of the contribution to Euratom. In the present state of this scheme, government co-operation has proved more effective in the field of fundamental than technological research.

The Science Policy Council in particular is of the opinion that for international technological co-operation non-government corporate bodies may be more effective and successful.

b) Space research and technology

In its second advisory report on space research and technology, the Science Policy Council estimated that an average annual expenditure of 40-42 million guilders during the period 1970-1974 would be appropriate. In the 1971 budget estimate 44.8 million guilders were allocated to this purpose. Possible execution of a modest national programme and participation in international co-operation projects is included in this amount. Among others are included contributions to ESRO, ELDO, GROC (Commission for Geophysics and Space Research of the Royal Netherlands Academy of Sciences) and part of the subsidy granted to the National Aerospace Laboratory (NLR).

The decrease in the expenditures for the national programmes is due to the decrease in the support of the Ministry of Economic Affairs for the National Astronautical Satellite.

From the beginning of space exploration, the Government gave its support to the European Space Research Organisation (ESRO). The most important establishment is the European Space Research and Technology Centre located at Noordwijk near Leyden university.

The Netherlands participates in all ESRO activities, i.e. the scientific programme and the studies on satellite systems for communication, navigation and meteorology. Several scientific experiments carried out in Netherlands universities have also been inserted into ESRO satellite programme.

In accordance with existing rules Netherlands industry attempts to participate in ESRO contracts. Since 1963 its efforts in the field of space technology have been concentrated mainly on participation in the work of the European Space Vehicle Launcher Development Organisation (ELDO). Dutch firms and the National Aerospace Laboratory have participated in development activities especially in the field of space electronics, aero-dynamics, guidance systems and integration.

To extend the know-how of Netherlands industry, Government and enterprises, supported by astronomers, embarked in 1969 upon the Astronomical Netherlands Satellite Programme (ANS). Funds for the industrial effort are supplied by the Ministry of Economic Affairs and those for scientific experiments by the Ministry of Education and Sciences. This programme interested American scientists and an agreement was concluded with NASA for its inclusion into NASA experimental work.

The furtherance of industrial capacities in space technology also led to governmental support in developing a ground station for communication with INTELSAT satellites on behalf of the Netherlands Postal and Telecommunication Services.

An Interdepartmental Committee on Space Research and Technology is charged with co-ordinating research activities in this field. Its members are civil servants representing the Ministries of Foreign Affairs, Finance, Economic Affairs, Education and Sciences, Transport and Water Management, Culture Recreation and Social Welfare.

At the end of 1969, the Government decided to extend the task of the Netherlands Aircraft Development Board (NIV) to problems of space. Since this formal change in the rules of the Institute its name has been changed into Netherlands Agency for Aerospace Programmes (NIVR). The supervision of the Astronomical Netherlands Satellite Programme (ANS) is now carried out by the NIVR.

6. DEFENCE

More recently, in order to ensure co-ordination of the national as well as the international relations of the entire defence R and D, the Minister for Defence created the Netherlands Defence Research Co-ordination Committee. This committee is presided over by the chairman of RVO-TNO and is composed of a representative of the Ministry of Foreign Affairs and four officers representing the Minister of Defence and the three Forces on the board of RVO-TNO.

In the 1971 budget estimate 52 million guilders, or 4.1% of total government expenditure on R and D, were allocated to defence R and D. This was equivalent to 1.3% of the total budget of the Ministry of Defence, a proportion which has been practically constant for the last years. Further details are given in the paragraph on the research in the field of defence in Chapter II of Part Two.

7. OTHER FIELDS

Taken all together, funds allotted to non-classified items and multi-departmental topics amounted to 24.3 million guilders in the 1971 budget estimate, which is about 2% of total government expenditure on R and D.

Two closely related topics are of particular importance: dissemination of scientific and technical information, and computer science.

a) Dissemination of scientific and technical information

In 1964 the Royal Academy of Sciences set up a committee to investigate whether, and in what form, problems of dissemination of scientific and technical information could be tackled in the Netherlands. The results of that investigation were expounded in a memorandum presented to the Minister of Education and Sciences. The Committee strongly recommended the establishment of a high-level centre for co-ordination and promotion of scientific information services.

As other organisations in the field of library science, documentation and industry also demanded government action, the Ministry of Education and Sciences, after consultation with the Royal Academy of Sciences, decided to entrust the more detailed planning of desirable measures to a broadly-based working group of experts.

In its recommendations this working group stressed the need for setting up a central body with the following terms of reference:

- lay down the principles of a national information policy;
- promote, co-ordinate, and whenever needed, subsidise scientific and technical information services in the Netherlands;
- co-operation with all producers and users of scientific and technical information;

- participate in international bodies for scientific and technical information.

The main policy objectives of this central institution should be:

- creation of a national network of information services linked as far as possible to those of other countries and implying an improvement of existing facilities and establishment of new documentation centres;
- training of workers in librarianship, documentation and information at various levels;
- analysis and introduction of existing, and new, methods and techniques, including those of data-processing by computers;
- development of new facilities enabling scientific workers to keep themselves informed and to make effective use of the available information.

In all its annual reports the Science Policy Council has endorsed the conclusions of the Working Groups report and suggested that the Government should take corresponding action. This led to the decision, in February 1971, to create a special central organisation: the Netherlands Centre for the Advancement of Information Handling (NOBIN).

b) Computer science

Direct government support for promotion of computer science is of rather recent date and still relatively small. In 1970 it amounted to 1.5 million guilders, of which 1 million guilders was supplied by the Ministry of Economic Affairs and 0.5 million by the Ministry of Education and Sciences.

In conformity with the advice of the Science Policy Council the Ministry of Education and Sciences decided to utilise the funds earmarked for this purpose mainly to stimulate the exchange of specialists and the development of post-graduate training of experts in this area.

As to the Ministry of Economic Affairs, its support is not directed towards producers of hardware but rather to promoting advanced computer application, among others, by contributing to expensive projects in the field of software programming. It is also anxious to stimulate joint studies concerning automation in specific economic sectors.

With respect to automation, it is fair to mention the development orders of the Ministry of Social Affairs and Public Health. These orders mainly concern measuring instruments for air pollution. This ministry also carries research oriented towards improving the utilisation of computers in hospitals.

Finally, the Ministry of Education and Sciences subsidises a training course for automation teachers. This course is given by the Foundation Informatica which also receives an annual contribution from the Ministry of Interior to stimulate its research activities in storing and retrieving information of use to decision-makers both in government institutions and business farms.

Government policy in the area of computer science research is co-ordinated by an informal working group of representatives of the above-mentioned ministries.

c) R and D Policy Fund

The R and D Policy Fund deserves particular mention. On the recommendation of the Science Policy Council a certain amount of government R and D money is put aside to finance unforeseen developments.

According to the Council, this can concern new international co-operation projects and new research projects on a multi-disciplinary basis requiring a multi-departmental approach.

In this framework such multi-disciplinary and multi-departmental subjects are supposed to be treated as clearly defined projects. They can be carried out in laboratories which are specialised in one field but which are capable of undertaking programmes of a broader multi-disciplinary character.

The first projects financed by R and D Policy Funds are very different in nature (Table 53).

As can be seen the R and D Policy Fund seems to be of particular interest in the case of projects extending over several years and included in the framework of middle-range budgetary planning which so far remains more or less theoretical.

d) University research

As in other European countries, the university in the Netherlands could not completely integrate the dual functions of teaching and research. On the one hand, the concept and requirements of research carried the day where goals were concerned: teacher recruitment conditions, duration of studies, elitist training. But on the other hand university also carries research oriented towards improving the utilisation of computers in hospitals.

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Table 53. DISTRIBUTION OF R AND D POLICY FUNDS

Thousands of guilders

	1970	1971	1972	1973	1974	1975
1. Applied research in the field of new techniques of aero-photography	17	2,017	2,500	2,000	2,500	1,716
2. ECC-Signal transmission project PTT	-	480	920	700	-	-
3. Contribution to the establishment of a cardiology hospital	500	1,500	-	-	-	-
4. Heart and vascular diseases	500	1,000	500	100	500	-
5. Modernisation of instrumental facilities	500	p.m.	p.m.	p.m.	p.m.	p.m.
6. Preparatory studies - European technological co-operation EEC	-	91	-	-	-	-
7. Census-monographies project	-	350	700	850	750	-
8. Squares systems	-	700	800	600	400	-
9. Brain- and behaviour	-	845	975	875	-	-
10. New projects	-	p.m.	p.m.	p.m.	p.m.	p.m.
Total	1,517	6,983	6,395	5,125	4,150	1,716

SOURCE: Ministry of Education and Sciences.

structure was determined by teaching requirements: number of teachers and budget calculated according to the number of students enrolled in each discipline; division of the university into chairs and faculties according to linear curricula independent of one another.

The introduction of a system of additional financing solely for research did not have the aim and still less the effect of altering the university structure. This method of financing concerned the teacher-researcher alone: in the case of projects submitted for the approval of faculty boards, as in that of the resources placed at their disposal. Similarly, the activities of these boards were determined by individually appointed teacher-researchers.

The rapid expansion of the traditional university has been caused mainly by the teaching sector and for the same reason: the growth of the number of students. The reforms necessitated by this altered state of affairs have also been conditioned by the requirements of student participation. In the field of research these reforms have been fairly limited. Virtually, wherever there was any conflict between the requirements of research and those of teaching, priority was given to the latter.

As regards the future, the problem in the Netherlands does not seem to be a possible decline in university research due to the predominance of teaching functions or inadequate adjustment of university structures, but rather how the decision-making centres in the research sector should be distributed. At the same time more difficulties will arise with regard to the quality of the staff. Hitherto, the faculty boards made no use of the latitude in strategy allowed them by the financial power at their disposal. This shortcoming was due to their composition and decision-making system on the one hand and to their method of financing, relating solely to individual projects, on the other.

The elements of a real university policy are to be found in the recent reforms. With a better reparation of the functions the universities should be able to take more account of research requirements in their internal structures. The reform on the inter-university level should facilitate planning of objectives and orientation of research in agreement with science policy bodies or research establishments outside the university.

Part Five

UNIVERSITY IN SEARCH OF NEW ENDS

I

THE UNIVERSITY EXPANSION

1. GENERAL SURVEY OF THE UNIVERSITY EDUCATION SYSTEM IN THE NETHERLANDS

The Constitution of the Netherlands stipulates that teaching is free, except for the supervision of the Government. Public education will be regulated by law.

University education in the Netherlands is regulated by the University Education Act (1960), which replaced the old Higher Education Act, dating from 1876, and by the new Academic Statute (1963). This statute, a Royal Decree, stipulates the fields of study and the conditions of examination. As a result of this Statute there is a fairly high degree of uniformity in university education.

The University Education Act, containing basic principles, regulates the objectives and statutes of the institutions of university education, the composition and powers of their governing bodies and the financial provisions. In accordance with the Constitution, the Act also recognises that anyone who wishes to open a private institution for university education, must notify the Minister thereof before and submit to him the rules or the statutes. In addition, the Crown may "designate" private institutions or bodies which, with regard to certain doctorates and other diplomas, have the same rights as state institutions. An Act designating a number of theological institutes is in preparation.

However, neither "notification" nor "designation" leads automatically to financing from public funds, for the act proceeds from the principle that though there is indeed a difference in government responsibility with respect to publicly and privately-provided university education, the level of the latter must conform to the former if private institutions are to qualify for state contribution (see also the section on financing university education). Conversely, the Government must provide the same

Table 54. "COMPLETE" UNIVERSITIES AND OTHER INSTITUTIONS AT UNIVERSITY LEVEL IN THE NETHERLANDS

COMPLETE UNIVERSITIES	ENROLMENT, APRIL 1970
State University at Leiden (1575)	10,853
State University at Groningen (1614)	9,332
State University at Utrech (1636)	14,512
University of Amsterdam (1632)	15,608
Free (Calvinist) University at Amsterdam (1880)	7,979
Catholic University at Nijmegen (1923)...	8,727
OTHER UNIVERSITIES	
State Technological University at Delft (1905)	9,848
State Technological University at Eindhoven (1956)	3,650
State Technological University at Enschede (1963)	1,439
State Agricultural University at Wageningen (1917)	2,682
Netherlands School of Economics at Rotterdam (1913)[1]	5,051
Catholic School of Economics at Tilburg (1927)	2,856
State Medical Faculty at Rotterdam (1966)	763
TOTAL	93,302

1) The Netherlands School of Economics at Rotterdam is the only non-denominational private institution of university education.

SOURCE: Netherlands Central Bureau of Statistics.

development possibilities for both kinds of university. So the Act embodies provisions common to both types of education as well as separate rules and regulations.

Public institutions have been also granted corporate status. Though they do not possess as much autonomy as private universities, they are in a position to act largely independently in university administration and management and in advancing the interest of university education and research.

University education is at present provided at the following six "complete" universities (Table 54); each comprising at least three faculties, one of which is medicine or mathematics and natural science, and seven other institutions at university level ("Hogescholen"), which contain fewer than three faculties or neither of the above-mentioned two faculties.

According to the University Education Act, university education has the following fourfold objectives:

- training of students for independent practice of science;
- preparation of students for fulfilling functions in society for which a university training is either required of may be expedient;
- to foster understanding of the inter-relation of sciences;
- to further a sense of social responsibility.

To meet these objectives the universities must, in any case, carry out scientific research, besides teaching. But because of recent development relating with its task, new functions of the university emerge, such as post-academic education in the system of permanent education, para-university training (of interpreters, teachers, etc.), post-graduate education.

2. THE INCREASE IN THE NUMBER OF STUDENTS

Uptil World War II, the universities developed gradually and were able to adapt smoothly to the steady increase of knowledge and the growing numbers of students. However, since the war the situation has changed completely. The number of students has shown a sharp increase in the last decade in particular. This can be illustrated by the following student enrolment figures: 1900: less than 4,000; 1938: about 12,500; 1955: about 30,000; in 1960: about 40,000; and in 1971: about 100,000. On the basis of the available data, it can be stated that the explosion in student numbers during the last decade (about 10% a year) will continue in the seventies.

With regard to the educational capacity of the universities, the general long-term policy of the Netherlands authorities is based upon the principle that the enrolment of students should be in line with the social demand for university graduates. However, in some cases the realisation of this principle has given rise to and will give rise to tensions between the numbers requesting education and the educational capacity available.

Under the University Education Act, everyone in possession of the appropriate secondary school leaving certificate (gymnasium, atheneum) or an equivalent qualification has the right to be admitted to university examinations. Moreover, admission to the individual faculties is governed by requirements with respect to the type of qualification (arts or science side: gymnasium A or B, atheneum A or B).

Further, there are numerous possibilities of admission to certain faculties with the leaving certificate of colleges offering vocational training. Although the law speaks of "admission to the examinations", in practice, this is equal to "admission to the preparatory courses for those examinations".

The tensions which have arisen in the last years have now forced the ministers to propose measures to limit the traditional freedom of university education. The irregular trend of student supply, leading to an incomplete and/or unequal utilisation of the available capacity, has resulted in several regulating measures regarding the admission of students in particular fields of study, especially medicine, medical dentistry and biology. In these fields of study, the Minister has established committees for distributing first-year students among the different universities. Because of overcrowding in the medical faculties in the last few years, Parliament, in July 1970, accepted an act including temporary provisions with regard to the regulation of students attending courses and working in laboratories in these faculties. The act aims at placing second-year students, who have passed their first examination, on a "waiting list" during one year.

Also, the Minister of Education and Sciences has endeavoured to reduce the excessive length of university studies.

The average length of the university courses in the Netherlands is in principle five or six years; often three years for the "kandidaatsexamen" and a further two years for the "doctoraal examen", but in many cases the proportions are different. Having passed the "doctoraal examen", the graduates can go on to take a doctor's degree by writing a thesis, while in some fields of study, such as medicine, the graduate must pass an additional examination before being admitted into professional practice. It should be said, however, that at present the normal conclusion of a university study is the "doctoraal" examination.

Besides the just-mentioned terminal degrees, there is also the possibility in some fields of study of obtaining the degree of "*baccalaureus*", but this terminal degree is not very popular: most "*baccalaurei*" continue to study for the "*doctoraal*" examination.

Although the average length of course leading up to the "*doctoraal examen*" is five years, the growing magnitude and the diversification of the contents of the courses in many fields of study on the one hand and a number of rather individual factors on the other, have caused a considerable extension of the actual duration of study - often two years or more.

This often excessive extension of the duration of study and the very high number of drop-outs - about 40% - together with requirements of modern society for university education call for other measures. Thus it is not only important to mention the intensive educational research efforts and the first steps to improve teaching and learning methods, but also a thorough inquiry into the aims, structure and content of university studies in general. This enquiry is being carried out by a Government Commissioner for University Education who has stated his view of the matter in a memorandum "University: objectives - functions - structures", which he submitted to the Minister of Education and Sciences in 1968.

According to the proposals of the Government Commissioner in this memorandum and a sequel based upon the consequent discussions, any university study must start with a selective year to be concluded by a propaedeutic examination. After this propaedeutic year, study is continued until the "*doctoraal examen*". The "*kandidaatsexamen*" is totally absolved. Generally, the length of a course leading to the "*doctoraal examen*" including the propaedeutic year should be fixed at four years - in some exceptional cases, five years. This new structure will mean in any case a curtailment of at least one year of the present length of study.

The Minister of Education and Sciences, basing himself upon the memoranda of the Government Commissioner, has already underlined the necessity for a more clearly structured vertical differentiation in university education, combined with a curtailment of the length of course and study.

Recently the Minister, on the basis of the recommendation of the Government Commissioner, has submitted to Parliament a draft law on this matter.

However, with regard to the legal provisions concerning the structure of university education, the Minister has stated that these provisions should be considered as interim regulations until such time as there is one single legal system for the whole of post-secondary education, since the Government shares the conviction that university education and higher vocational education cannot be treated as isolated entities. At present there is a considerable rate of attrition - 40% - among the student population at very expensive universities. Had these students gone to a less expensive higher vocational college the results might have been more satisfactory.

These reforms can only be carried out in agreement with the students and implemented by the universities: the students are strongly opposed to the introduction of the propaedeutic year as a means of selection. Under the Higher Education Act, it is for the faculties in the first instance to determine the length of courses. Thus, the University of Wageningen has drawn up a new programme comprising five years of actual studies, the last two tying in with a research programme.

These measures serve to reduce the number of students actually studying but not the number of applications for university admission. A considerable increase in applications may be expected for a number of reasons: a more rapid population growth than was foreseen; higher per capita incomes and a consequently higher rate of participation in long-course secondary education; and finally more equal opportunities for admission to the university. The review of Netherlands educational policy revealed the low proportion (8.5% in 1961 and 9.4% in 1965) of grammar school graduates, the pronounced under-representation of the lower social classes, and the over representation of the middle and upper social classes.

The explosive increase in the number of students at the Netherlands universities has necessitated a continuous review of its prospects. Recent estimates have been made by the Committee for Statistical Investigation of the Netherlands University Council, which published a report in 1968 on the need for, and supply of, university graduates. In this report the Committee estimates the number of students to be expected up till 1980 and brings forward three estimates: 110,000, 130,000 and 150,000 students in 1980. In 1968 it was still impossible to qualify one of these alternative estimates as the most probable. Since that time the highest alternative estimate is considered the most realistic. Moreover in the course of 1970, it appeared that even this estimate (150,000 students in 1980) will be too low.

In the light of this development the Committee for Statistical Investigation of the Academic Council has recently presented new estimates of student numbers. The trends, adopted for the period up to 1980 have been extended up to 1990. The Committee has also endeavoured to take into account as far as possible the consequences of restructuring secondary as well as university education according to the number of students in these estimates.

In its 1970 report, the Committee concludes that in the seventies and eighties the number of students at Netherlands universities will develop in a way that is as explosive as the development of the past decade.

As far as the year 1980 is concerned the Committee expects 130,000 student enrolments at least or 175,000 at most. Table 55 shows the estimates of student numbers by fields of study according to the different alternatives.

As far as the estimates for the year 1990 are concerned, the Committee has not gone into any detail in view of the high degree of uncertainty involved. Table 56 shows the number of students by group of fields of study for the years 1980 and 1990.

The estimates for the years 1980 and 1990 give the greatest variation with respect to the social sciences. This is due to uncertainties concerning variations in the transition of students from secondary to university education. The variation in the B-fields of study can be attributed in a greater degree to the expansion of secondary education.

Graphs 6 shows how the future development of the student population has been forecast by the most important bodies in this field since 1950. The estimates quoted in this graph have corresponded more or less with the trend during the years preceding them. The great difference between the results of the estimates of the Committee of the Netherlands University Council in 1968 and 1970 is mainly due to the fact that it recently appeared that the increase in the number of pupils in the secondary educational system, and in the transition of those pupils to university education, will be more important in the next few decades.

3. THE INCREASE IN UNIVERSITY PERSONNEL

The enormous development of university education in the last few years has led to many and varied problems concerning the increase in university staffs.

The assessment of the personnel formation of each university is based upon particular ratios between the number of students and the number of scientific personnel and upon empirically calculated relations between the number of scientific personnel and the other personnel groups.

Table 55. NUMBERS OF STUDENTS BY FIELDS OF STUDY ACCORDING TO ALTERNATIVE ESTIMATES, 1968, 1975 AND 1980

Thousands

	1968	1975		1980			
				HIGH¹		LOW¹	
		HIGH²	LOW²	HIGH²	LOW²	HIGH²	LOW²
Theology	1,9	2,3	2,3	2,5	2,5	2,5	2,5
Law	9,7	17,0	16,1	25,0	20,5	20,5	18,0
Social Sciences	6,7	12,0	11,3	19,0	17,5	17,5	15,0
Letters	8,6	11,1	10,6	18,0	17,0	17,5	15,5
Economy	9,0	12,1	11,6	16,5	16,0	15,0	14,5
Psychology	4,7	8,2	7,8	11,0	16,0	10,0	9,5
Earth Sciences	1,5	2,6	2,6	3,5	-	3,0	3,0
Others	2,4	6,4	5,9	11,5	10,0	10,0	9,0
Science	11,5	15,8	15,4	20,5	19,5	18,5	17,5
Technology	13,6	19,1	18,8	24,0	23,5	22,0	21,0
Medical Sciences	10,7	13,0	12,7	16,0	15,0	14,5	13,5
Dentistry	1,6	2,1	2,0	2,5	2,0	2,5	2,5
Veterinary	1,2	1,3	1,2	1,5	1,5	1,5	1,5
Agr. Sciences	2,3	3,5	3,4	5,0	4,5	4,5	4,0
TOTAL	84,8	126,0	122,0	175,0	165,0	160,0	150,0

1. Alternative pre-suppositions concerning the admission to secondary education and a pre-university education stage.
2. Transition to university education.

Table 56. NUMBERS OF STUDENTS BY GROUPS OF FIELDS OF STUDY ACCORDING TO DIFFERENT ALTERNATIVES, 1980 AND 1990

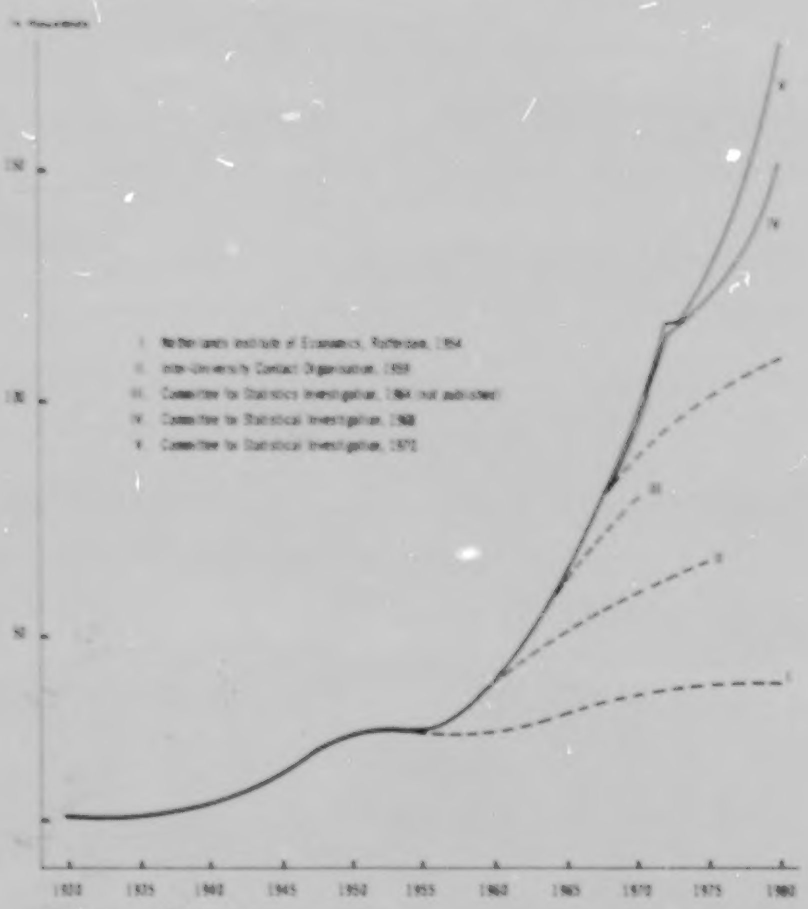
Thousands

	1980				1990			
	HIGH[1]		LOW[1]		HIGH[1]		LOW[1]	
	HIGH[1]	LOW[2]	HIGH[2]	LOW[2]	HIGH[2]	LOW[2]	HIGH[2]	LOW[2]
A - Fields of study	20.5	19.51	19.5	18.0	37.0	34.0	29.0	26.0
B - Fields of study:								
Science, natural sciences and technology	44.5	43.0	40.5	39.0	75.0	71.0	59.0	56.0
Medicine, dentistry	18.5	17.5	17.0	16.0	30.0	26.0	23.0	21.0
Veterinary	6.5	6.0	6.0	5.5	11.0	10.0	8.0	8.0
C - Fields of study	85.0	77.5	76.5	70.0	147.0	129.0	115.0	102.0
TOTAL	175.0	165.0	160.0	150.0	300.0	270.0	235.0	215.0

1. Alternative pre-suppositions concerning the admission to secondary education and a pre-university education share.
2. Transition to university education.
A - Fields of study: theology, and letters.
C - Fields of study: law, social sciences, economics, psychology, earth sciences and others.

Graph 6

NUMBERS OF STUDENTS UP TO 1980,
ACCORDING TO ESTIMATES SINCE 1950



Source : Netherlands Office of Planning.

These so-called "rules of thumb" have as their starting-point the following scientific staff/students ratio:

- 1:12 for the faculties of human and social sciences;
- 1:7 for the faculties of mathematics and natural science and engineering;
- 1:5 for the medical faculties (including dentristry and veterinary).

These rules of thumb are at present under consideration because they are out-of-date.

The quantitative expansion in the last five years in the different universities (except that of the Medical Faculty of Rotterdam) is shown in Table 57.

For 1969, the Ministry of Education and Sciences gives a breakdown of university population by main categories. These figures make it possible to calculate the student/scientific staff ratio, which differs quite considerably per discipline (Table 58).

Moreover, figures are given of the total number of scientific personnel, broken down in numbers of full professors, full lecturers, etc.

4. THE INCREASE IN THE NUMBER OF INSTITUTIONS OF HIGHER EDUCATION

To meet the demand for university education the Government has, during the last decade, increased its efforts with regard to the expansion of the existing institutions of university education and the recent establishment of new institutions.

In the first postwar years Government industrial policy clearly necessitated an expansion of university education, above all in the field of technology. This resulted in the extension of the technological university at Delft and in the creation of a second technological university at Eindhoven in 1956.

Meanwhile it was becoming more and more evident that the problems of the training capacity and the structure as a whole needed to be tackled more systematically. Therefore two committees were established in 1957 and 1958: the Committee for the Expansion of University Education and the Committee for the Expansion of Higher Technological Education. In 1959 the two committees issued a joint report dealing with the quantitative, qualitative and regional aspects of expanded university education.

Table 57. EXPANSION OF THE PERSONNEL OF THE UNIVERSITIES
IN THE PERIOD 1965-1970 (IN INDEX FIGURES): 1965 = 100 (IN FULL-TIME EQUIVALENTS)

	TOTAL PERSONNEL	SCIENTIFIC PERSONNEL	TEACHING STAFF
Leiden	125.7	125.3	127.8
Groningen	151.3	145.0	150.1
Utrecht	145.6	138.4	136.8
Amsterdam (Municipal University)	162.3	185.8	138.5
Amsterdam (Free University)	161.4	160.8	164.3
Nijmegen	142.5	161.4	156.5
Rotterdam (School of Economics)	209.4	177.4	127.9
Tilburg	201.1	182.3	140.6
Delft	123.7	120.6	130.0
Eindhoven	124.7	147.4	157.4
Twente	186.9	174.4	180.9
Wageningen	131.1	[illegible]	130.7

Table 58. NUMBER OF STUDENTS, FULL PROFESSORS AND TOTAL SCIENTIFIC PERSONNEL PER FACULTY

	(a) STUDENTS[1]	(b) FULL PROF.	(c) TOTAL SCIENTIFIC PERSONNEL[2]	(d) TOTAL SCIENTIFIC AND TECHNICAL PERSONNEL[2]	(e) STUDENT/ SCIENTIFIC STAFF RATIO
Theology	2,015	61	202	247	9,98
Letters	16,771	202	1,138	1,417	9,47
Medicine	12,786	306	4,138	7,335	3.09
Veterinary	1,205	21	2,298	687	-
Science	13,585	286	2,436	5,149	5,58
Technology	14,684	198	1,172	3,107	12,59
Agricultural Science	2,550	71	506	1,489	5,04
Law	11,074	148	592	746	18,07
Economics	9,691	95	505	600	19,15
Political and Social Sciences	15,888	136	1,169	159	13,59
Philosophy	477	32	99	126	13,36
Central inter-faculties for geology and prehistory	1,787	18	135	211	13,30
TOTAL	98,513	1,568	14,392	21,267	6.61

1. Personnel: revised budget 1970, Students: figures from Netherlands Office of Statistics for the academic year 1969-1970.
2. In full-time equivalent.

On the basis of this report and other recommendations, the Minister of Education, Arts and Sciences submitted to Parliament a "Memorandum on the expansion of university education". He agreed with the recommendation of the Committees that priority should be given to the improvement and expansion of the training capacities of existing universities. This would be achieved by the creation of new faculties or branches of study and by increasing staff as well as by providing for more equipment and accommodation in these institutions. However, the Minister was also aware that it was desirable to promote a certain decentralisation of university education by setting up new institutions.

Most of the measures considered necessary by the Minister were implemented in the years following. For example, a third technological university was opened at Enschede in 1964, and at the beginning of the academic year 1966-67 an independent medical faculty opened its doors in Rotterdam, while a number of new faculties were created in the older institutions.

In 1969 the Minister submitted to Parliament a "Memorandum on university education in medicine", in which he proposed the establishment of a new - eighth - faculty of medicine in Maastricht at the end of the seventies. This proposal was approved by Parliament in 1970. Preparations for the establishment of this faculty have been started by a special committee.

In the recently published note referring to the development plans of the universities for the period 1969-72, the Minister of Education and Sciences has stated that it is already possible to formulate some points of the policy with regard to expansion of university education in the next few years. The Minister aims at establishing a university in Rotterdam by merging the Netherlands School of Economics and the Medical Faculty; the enlargement of the Technological University of Enschede into a complete university; the enlargment of the future medical faculty at Maastricht into a university; the development of a university of Brabant by combining the Technological University of Eindhoven and the Catholic School of Economics of Tilburg. A committee of both institutions has been established to investigate the possibilities of more intensive co-operation and the expansion of both universities.

5. THE INCREASE IN THE GOVERNMENT EXPENDITURE ON UNIVERSITY EDUCATION

The postwar expansion of university education has caused an enormous increase in government expenditure on university education, which rose from 50 million guilders in 1950 to 1,334 million guilders in 1967.

In relation to total government expenditure on education this category increased considerably during the last two decades: namely from 9% in 1950 to 23.7% in 1967. Government expenditure on university education as a percentage of national income shows an increase from 0.3% in 1950 to 1.8% in 1967. In addition it should be noticed that grants stemming from the second flow of funds and from contract research have not been taken into consideration in these figures of expenditure on university education.

In 1950 central government expenditure on education amounted to 7.3% of the total central government budget, in 1970 to 25.3%. The increase of this proportion for university education was much higher: from 0.9% in 1950 to 6.1% in 1967.

At present total State expenditure on education is estimated at 28% of the State budget, the expenditure on university education at about 5.8%.

In general the category "personnel" forms about 40-50% of the universities' budget. Concerning the category "other current expenditures" the ministers have assessed an annual increase of 10% for the faculties of humanities and social sciences and 13% for the other faculties during the period 1966-1969.

Capital expenditure, almost a quarter of the budget of the universities, includes expenditure on construction and reconstruction of buildings and capital expenditure on scientific research. These last two categories of expenditure were introduced in 1966 and are aimed at extra-university activities as well as fields of university research that are only of importance to a relatively small number of students. Of total investments by all universities in 1966 (366 million guilders) the sum of 35 million guilders was allocated for this purpose. Every year thereafter this amount has been adjusted to the general level of prices. In the draft budget for 1971, this sub-category was increased to about 50 million guilders, while total capital expenditure amounted to 531 million guilders.

Finally, the category "extension of equipment in the existing buildings" amounted to almost 71 million guilders in 1970. Because of the growth of research as well as the development of equipment, such as computer facilities, this category is likely to increase rapidly in the years to come.

In its 1970 report the Committee for Statistical Investigation of the Netherlands University Council calculated the financial implications of its estimates of the development of student numbers up to 1990. The results of this calculation are given in Table 61 as far as the highest and lowest estimates of student numbers are concerned.

Table 59. GOVERNMENT EXPENDITURE ON UNIVERSITY EDUCATION IN RELATION TO NATIONAL INCOME AND TOTAL GOVERNMENT EXPENDITURE ON EDUCATION

	1950	1960	1965	1967
National income (market prices) (million guilders)	17,056	38,823	63,358	75,760
Total government expenditure on education (million guilders)	557	2,006	4,344	5,687
Government expenditure on university education (million guilders)	56	228	899	1,334
Government expenditure on education as a percentage of national income	3.3	5.2	6.9	7.5
Government expenditure on university education as a percentage of national income	0.3	0.7	1.6	1.8
Government expenditure on university education as a percentage of total government expenditure on education	9.6	14.4	20.7	23.7

SOURCE: Centraal Bureau voor de Statistiek, *Uitgaven voor het wetenschappelijk onderwijs*, Den Haag, 1970.

Table 60. RATIOS OF STUDENT/SCIENTIFIC STAFF RATIO AND STUDENT/TOTAL PERSONNEL IN 7 FACULTIES IN 6 UNIVERSITIES (1970)

	THEOLOGY		LAW		ECONOMY		SOCIAL SCIENCES		LETTERS		MEDICINE		MATH/ NAT. SC.	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Leiden	10, 6	6, 5	19, 7	14, 6	-	-	14, 2	10, 3	9, 8	7, 6	4, 7	1, 7	7, 0	2, 8
Groningen	7, 7	6, 0	24, 8	19, 2	14, 7	12, 1	16, 7	12, 5	13, 2	9, 5	5, 2	2, 0	5, 8	2, 5
Utrecht	14, 4	10, 7	21, 4	16, 3	-	-	15, 8	11, 4	8, 2	5, 8	4, 8	2, 2	5, 8	3, 0
Amsterdam (MU)	8, 5	6, 7	15, 7	11, 4	17, 4	12, 5	16, 1	9, 6	11, 9	8, 2	4, 0	1, 6	5, 5	2, 4
Amsterdam (FU)	14, 3	10, 7	19, 7	17, 1	23, 6	21, 5	13, 2	9, 9	8, 4	7, 0	6, 9	2, 5	6, 0	2, 6
Nijmegen	9, 8	6, 9	28, 2	18, 1	-	-	13, 0	8, 6	10, 2	7, 7	4, 8	1, 7	6, 5	2, 6

a) Number of students per member of scientific staff,
b) Number of students per member of total personnel,

Table 61. NUMBER OF STUDENTS AND GOVERNMENT EXPENDITURE FOR UNIVERSITY EDUCATION (MILLIONS OF GUILDERS, PRICES 1970), 1970-1990

	1970	1980		1990	
		HIGH	LOW	HIGH	LOW
Number of students (thousands)	100	175	150	300	215
Government expenditure for university education personnel	1,060	2,600	2,200	6,100	4,500
Other current expenditure .	490	1,200	1,000	3,400	2,400
Other current investments	450	1,000	600	900	500
Total governement expenditure for university education	2,000	4,800	3,800	10,400	7,400
id. as % of GNP	18	30	24	45	32

In this calculation the Committee has taken into account the effects of the variations in the repartition of students over different fields of study caused by the assumed changes in study preferences. Secondly, the Committee has based its estimation upon an unchanged relationship between the number of students and staff members and upon a constant relative salary position of the latter group. In the category of "other current expenditure" the Committee has taken into account an annual increase resulting from an improvement in the quality of the equipment concerned.

According to this estimation government share of expenditure on university education in 1980 will be 3%, and in 1990 4.5% of GNP.

II

TOWARDS A NEW UNIVERSITY POLICY

1. PRINCIPLES OF AUTONOMY

Legislation, passed in 1970, on the internal organisation of the universities came into force in 1971.

The new legislation provides for three levels of organisation and decision-making: the university, the faculty and the teaching and research unit. It is characteristic that the Act of 1970 should present the university structure with the faculties and sub-faculties preceding the central university bodies (council, rector, etc.). Major powers are assigned at the base, according to the principle that the decision-making power should be where the management power is. Under these circumstances, the higher bodies now perform mainly a co-ordinating function.

The central bodies of the university are therefore in a delicate position; they are caught between the requirements at the base, which they have to interpret and co-ordinate, and the supervisory authorities on which they depend for financing. Under these conditions, the question is how much room they will have in which to manoeuvre: will they be able to particularise their university in the system as a whole and endow it with special characteristics?

a) The university bodies

The three levels of the university (central, faculty and lower bodies) are governed by the same principle in the form of a controlling council and executive committee. The faculty system would appear to conform to a highly traditional concept but the lower level, namely the teaching and research unit, seems to be much more innovative.

i) The university

Hitherto public universities and, generally speaking, the private institutions too were administered by a "College van curatoren" (Board of Governors), appointed by the Crown (or supporting foundation) and a Senate composed of the professors. The Board, presided over by the "president-curator", assured compliance with the legislation and the ensuing regulations and was responsible for the accommodation and the control of finance and movable and fixed assets. The Board used to submit the report of the university to the Minister every year. The Chairman of the Senate, "Rector Magnificus", was concerned with the general interests of education and science. Actually the greater part of the Senate's task was carried out by the faculties or departments in which the universities are sub-divided.

The new University Administration (Reform) Act, 1970 aims at promoting democratisation of the university administration and the continuous and efficient functioning of the university in accordance with its aims and tasks.

In the new organisational structure (Chart 3) the highest authority within the institutions is the university council, with at most 40 members, who are elected or appointed for at least 2 years. For the students the minimum period is at least 1 year. At least one-sixth of these members will be recruited from outside the university community. The other five-sixths consist of at least one-third of members of the scientific staff, not more than one-third of students and at most one-third of non-scientific staff.

The Council's responsibilities include laying down a set of rules and regulations outlining the internal organisation of the university. The council assesses the budget, subject to approval by the Minister. The other tasks of the council include the drafting of a development plan and a financial programme. Moreover, the council outlines directives for the organisation and co-ordination of educational and scientific activities.

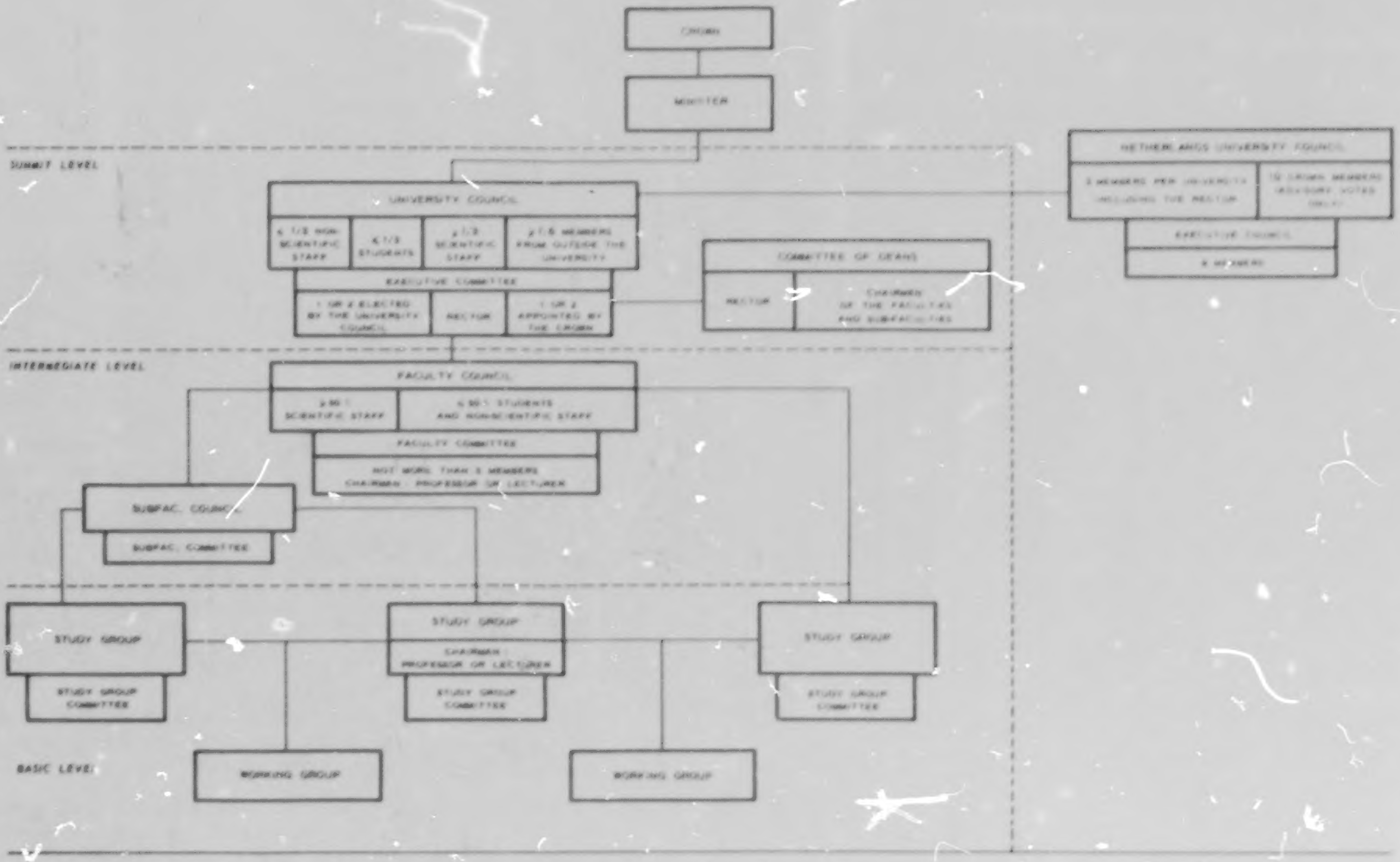
The day-to-day administration of the university is in the hands of an Executive Committee of three or five members, one of whom is the "Rector Magnificus", while the others are partly designated by the council from among members of the academic staff holding permanent appointments, either from among its own members or not, and partly by the Crown c.q. supporting foundation. With the institution of the University Council the Board of Governors and the Senate cease to function.

ii) Faculty and sub-faculty

The faculty council is responsible for the administration of the faculty. Representatives of the science staff account for at least half

Chart 3

SCHEME OF THE BODIES WHICH HAVE BEEN MENTIONED IN THE DRAFT BILL REFORMS IN THE ADMINISTRATION OF THE UNIVERSITIES 1970


CROWN
MINISTER
SUMMIT LEVEL
UNIVERSITY COUNCIL
≤ 1/3 NON-SCIENTIFIC STAFF
≤ 1/3 STUDENTS
≥ 1/3 SCIENTIFIC STAFF
≥ 1/6 MEMBERS FROM OUTSIDE THE UNIVERSITY
EXECUTIVE COMMITTEE
1 OR 2 ELECTED BY THE UNIVERSITY COUNCIL
RECTOR
1 OR 2 APPOINTED BY THE CROWN
COMMITTEE OF DEANS
RECTOR
CHAIRMEN OF THE FACULTIES AND SUBFACULTIES
NETHERLANDS UNIVERSITY COUNCIL
3 MEMBERS PER UNIVERSITY INCLUDING THE RECTOR
10 CROWN MEMBERS (ADVISORY VOTES ONLY)
EXECUTIVE COUNCIL
8 MEMBERS
INTERMEDIATE LEVEL
FACULTY COUNCIL
≥ 50% SCIENTIFIC STAFF
≤ 50% STUDENTS AND NON-SCIENTIFIC STAFF
FACULTY COMMITTEE
NOT MORE THAN 5 MEMBERS
CHAIRMAN : PROFESSOR OR LECTURER
SUBFAC. COUNCIL
SUBFAC. COMMITTEE
STUDY GROUP
STUDY GROUP COMMITTEE
STUDY GROUP
CHAIRMAN : PROFESSOR OR LECTURER
STUDY GROUP COMMITTEE
STUDY GROUP
STUDY GROUP COMMITTEE
BASIC LEVEL
WORKING GROUP
WORKING GROUP

its membership, the other half being elected from among the students and the non-science staff. The legislation leaves it to the university to determine the total number of persons who will sit on the council. If the faculty has sub-faculties, the latter will designate those of their members who will sit on the faculty council. The council is chaired by a dean.

The functions of the Council are extremely wide-ranging, since they comprise "the organisation and co-ordination of teaching and research in the subject of the faculty". The Council should determine the curricula for each discipline and recommend the appointment of readers and lecturers.

The faculty council elects from among its members or persons outside an executive committee of five who hold office for at least one year. The council elects the chairman of the executive committee from among the full-time professors and lecturers for a term of at least three years; their appointee thus becomes the dean of the faculty. The executive committee is responsible for the day-to-day handling of affairs; it prepares the council meetings and puts the council's decisions into effect. The faculty council appoints standing committees for teaching and research, most of whose members are on the university staff.

iii) Teaching and research units, research groups and institutes

"For the organisation, co-ordination and integration of the work of those concerned with any one subject (or groups of subjects) the council of the faculty to which the subject belongs will set up a teaching and research unit".

These units form the smallest cell of the university and replace the former chairs. The committee of the teaching and research unit comprises the professors, lecturers, junior teachers and other members of the university staff who, as members of the unit, are on the permanent teaching establishment. It is for the faculty council to determine who else may become a member of the committee.

The committee draws up an annual research and teaching programme approved by the faculty council; the committee is responsible to the faculty council for its implementation.

Two or more units may form a research group with the approval of the faculty council or councils concerned. Each year the group draws up a programme of interdisciplinary research, which is submitted to the faculty council for approval. Persons outside the university may take part in the group's work.

The institutes are administrative units which assist the teaching and research units in the same way as they do the research groups.

b) Ministerial supervision

i) Administrative supervision

Membership of the executive bodies: at least one-sixth of the members of the university council are to be recruited from outside the university community and are appointed on the recommendation of the council by the Minister of Education and Sciences (or, in case of private universities, by the supporting foundation).

The executive committee consists of 3 or 5 members. After consultation the university council, the Crown (or the foundation board in the case of a private university) appoints one or two members respectively to the committee. The duration of appointment is laid down by the Crown. The chairman of the executive committee is appointed from among the members by the Crown (or the association or foundation board).

Decisions: The council's responsibilities include drawing up a set of rules and regulations outlining the internal organisation of the university.

These rules and any amendment must be approved by the responsible minister insofar as public institutions are concerned, and by the board of the association or foundation in the case of private institutions. In the latter case ratification by the Minister is also required.

Decisions by the university council that are not subject to ministerial approval may in extreme cases be suspended and annulled by the Crown at the proposal of the executive committee on account of their being at variance with the law or the public interest.

ii) Financial supervision

Since a revision of the University Education Act (1960) was approved with regard to the financial equalisation of private and state universities in 1970, the Government has taken full responsibility for meeting total current and capital expenditure by all university institutions, insofar as this expenditure does not exceed the accepted standards.

For the assessment of the annual State contribution to the universities the boards of governors of each of the public, as well as of the private, institutions submit an annual budget to the Minister of Education and Sciences for approval; an exception is the Agricultural University at Wageningen, which submits its budget to the Minister of Agriculture and Fisheries. Apart from this annual budget, each university has annually, at the same time, to submit a financial scheme comprising estimates for the four years following the budget year.

In drawing up the General Financial Scheme the ministers have to take into account two main criteria, namely: the equitable development possibilities of all universities and a reasonable division of tasks. The university authorities will use the General Financial Scheme as a guide in drafting their budget proposals to the ministers.

It stands to reason that each university in drafting its budget proposal is allowed to depart from the provision made in the General Financial Scheme, because the budget proposals show in more detail than the financial plans of the universities and the General Scheme what should be considered to belong to the equipment of the universities in the years concerned.

In two respects, however, the university is able to act autonomously in the drafting of this budget procedure.

The first is that it is free to use as it sees fit the public money appropriated to it. Expenditure is, of course, verified subsequently: this is done by a university comptroller and the Netherlands audit office. Essentially, however, the university is free to spend the sums it receives as it thinks best, even the investment budget. This freedom is particularly significant in regard to personnel formation.

The sole requirement imposed on the university is to accept the establishment of teachers appointed by the Crown. Otherwise, the university uses its appropriations freely without having to observe the student/teacher ratios used by the Ministry to calculate the number of posts assigned to each university.

The second source of autonomy is the fact that only part of the university budget is under the control of the Ministry of Education.

The income of the universities consists, besides the above-mentioned State contribution, of: fees (matriculation, tuition, examination), donations, etc. and other remunerations for services rendered. These remunerations consist of grants from the so-called "second flow of funds" which the university institutes receive through the Netherlands organisation for the Advancement of Pure Research (ZWO) and through other scientific foundations for special research projects, and of income from research carried out at the request of non-university bodies (industry). This income from contract research is not incorporated in the annual university budgets. The actual amount of this income is still unknown, even to the university authorities.

But external resources may be considerable, amounting to several million florins annually.

2. PLANNING PROCEDURES IN UNIVERSITY EDUCATION

The University Education Act (1960) states in general terms that once in a four-year period each university and inter-university institute draws up a development plan for education and research outlining its policy and medium-term planning with - if possible - a longer-term view. These development plans should be submitted to the Minister of Education and Sciences as well as to the Netherlands University Council. Besides, each institution has to submit an annual financial scheme in which estimates are given for the four-year period following the budget year. Upon the basis of those financial schemes of the universities, the Government prepares a General Financial Scheme for the universities and submits this, annexed by the financial schemes of the individual universities, to Parliament. The General Financial Scheme aims at the allocation of the resources to be made available to university education and research in the next four years, within the framework of the general financial and economic policy, and to be divided among the universities.

In the Act the question of which policy issues should be included in the development plans has been left open to practice. After the completion of the first series of plans (for the period 1963-1966) the Netherlands University Council drafted more precise guidelines for the formulation of future development plans. These guidelines, approved by the Minister, offered to the university institutions a point of departure for a systematic approach to the whole area of their education and research activities.

According to these guidelines the universities have in their second development plans (for the period 1969-1972) paid attention to the function, administration and management of the university and relevant general problems, such as structure, task and method of task fulfilment of the administrative apparatus, staff policy, building policy and provisions for students. As to education, the plan elucidates special new developments in connection with curricula, measures and inquiries aimed at improving study results and so forth.

Besides, the development plans must contain chapters on scientific research, inter-university co-operation, numerical data of non-financial nature and a summary of future current expenditure and of total capital expenditure. On receipt of the advice of the Academic Council, the Minister presents this advice and the development plans to Parliament together with his own memorandum, in which he gives his considerations on the development plans and his personal view of the policy with regard to university education in the next few years. On the basis of these documents Parliament has a discussion with the ministers.

The scope and complexity of the problems involved in the university's expansion policy have convinced the Minister of Education and Sciences of the necessity of establishing a permanent advisory body, the Committee for the Development and Extension of University Education, in 1970. The task of this committee is,

a) to carry out studies and to make - if possible - alternative recommendations with regard to the development of university education in the long run and if necessary in relation to other sectors of education.

b) to advise the Minister on decisions soon to be taken concerning the expansion and regional pattern of university education.

The Committee is asked to take into account the proposals of McKinsey and Co. Inc. concerning the establishment of a national planning structure for post-secondary education.

McKinsey Proposals

In its reports of 1970 and 1971 McKinsey has made proposals to improve the planning of post-secondary education in the Netherlands. These proposals consist of a planning procedure and herewith connected organisation structure for both university and higher vocational sectors of education. They are based upon the consideration that the ministers concerned and the post-secondary educational institutions together carry the responsibility for the planning insofar as the political responsibility to Parliament rests with the ministers.

McKinsey proposes to introduce, apart from the existing planning per institution, a planning per group of university disciplines and type of higher vocational training. The reason for this is that the demand for education as well as the societal need of graduates is manifest per discipline.

With regard to the planning process McKinsey recommended a three-phase planning process (long-range planning, medium-term planning and budget planning), based upon an approach by discipline. A recommendation is made to develop firstly a long-range planning which will identify by discipline the needs of post-secondary education for the coming 10-year period and develop policies and programmes to meet these needs. On the basis of this plan, which will be updated annually, each institution of university education and higher professional education should also establish annually a four-year plan of action (the actual development plans) by discipline. In the short-term, annual budgets will be drawn up by the individual institutions on the basis of the plans of action during the medium-term planning. Because the medium-term planning forms a basis for the budget, it is necessary to revise medium-term plans every year.

Concerning the organisational implications of this planning process, McKinsey proposes the creation of two new bodies: a National Steering Group for Planning Post-secondary Education, offering the Minister expert recommendations in all planning decisions with policy implications, and a national Planning Staff for Post-secondary Education to give the required analytical support to the Minister, the National Steering Group and other participants.

These proposals have been accepted by the Government. A working group was charged with testing the proposal procedures in some disciplines. After these successful attempts, preparations are made to introduce fully the proposed planning system in the Netherlands.

III

UNIVERSITY RESEARCH IN THE NETHERLANDS

Although most people still hold the traditional view that university teaching and research should go hand in hand, various developments have created a situation in which putting the principle into practice is fraught with difficulty. Particularly the view that university teaching and research must be completely interwoven is becoming increasingly untenable.

In his memorandum on the 1969-1972 development plans the Minister of Education and Sciences recommends that research forming part of the university curriculum should be indissolubly bound up with university teaching. This condition does not apply to research with no direct bearing on teaching. The Minister also states that the universities are in an eminently suitable position to make a substantial contribution to the development of science by reason of their autonomy within the limits set by the available funds, the atmosphere of freedom in which the researcher can work, his opportunity for inter-departmental contact and the stimulating interaction with academic teaching.

In view of the substantial resources made available by the Government for research and the problems connected with their allocation by the university authorities, the Science Policy Council and many other authorities believe that more effective steps should be taken to formulate an intra-university research policy and an inter-university research policy incorporated in a national science policy.

1. GOVERNMENT EXPENDITURE ON UNIVERSITY RESEARCH

As in most other countries university research in the Netherlands enjoys a long tradition and this partly accounts for its importance in the country's total R and D effort.

Netherlands expenditure on university research as a proportion of the Gross National Product is high in comparison with eleven of the other OECD countries. The more recent figures submitted by the European Communities' Statistical Office show that the Netherlands Government expenditure on university research, from which about 90% of all its university research activities are financed, constitutes in absolute terms almost half as much as the corresponding French expenditure (see Table 62).

The importance attributed by the Netherlands Government to the university sector is further illustrated by the high proportion of total R and D resources devoted to university research (46% in 1969) and by the the high increase rate of expenditure in this sector.* The research funds form about a third of the total university budgets.

Table 63 gives the distribution of expenditure per faculty in 1971 divided into operating expenses and capital investment. The mathematics and physics faculties are shown to have the highest R and D expenditure, followed first by technical science and then be medicine. The total expenditure for agricultural science and letters is roughly equal. It is striking, however, that capital investment for agricultural science, as for all the other science faculties, is proportionately much higher than that for the humanities.

Table 64 uses the results of the 1964 CBS enquiry to show R and D expenditure for a number of university disciplines.

2. ORGANISATIONAL ASPECTS OF UNIVERSITY RESEARCH

The recent development plans drawn up by the universities show that the enormous increase in student numbers and the new teaching methods, which take up more of the lecturer's time, have in recent years threatened to upset the balance of teaching and research within the universities. The universities point out the acute danger that, faced with a disproportionately large number of undergraduates, university teachers will often be forced to give first priority to teaching at the expense of research. The absence of feedback will in its turn have definite repercussions on the standard of teaching. Moreover, the increased pressure under which research has to be carried out will restrict student participation. The situation calls for immediate attention, since research for the benefit of learning is not a question of prestige but a vital necessity. Last statistics on the breakdown of the real time devoted to R and D by the university staff reveal that it is lower than according to previous estimates.

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* If revised in accordance with the provisional results of the 1969 survey, this percentage would be 44%.

Table 62. UNIVERSITY RESEARCH EXPENDITURE IN COMPARISON WITH EEC COUNTRIES

		GERMANY	BELGIUM	FRANCE	ITALY	NETHERLANDS	EEC
1.	Public R and D expenditure 1969, in millions of u.a.[1]	493.1	34.0	282.9	108.0	125.5	1,043.5
	of which; international contributions	-	-	-	-	-	-
2.	Public R and D expenditure 1969, as % of total public R and D expenditure	34.3	32.0	14.1	32.4	46.4	25.1
3.	Mean rate of variation in public R and D expenditure 1967-69 (%)	12.1	11.9	21.2	10.5	14.7	14.5
	1969-70 (%)	10.0	13.9	2.4	11.9	17.4	9.2
4.	Per capita public R and D expenditure 1969, in u.a.	8.2	3.5	5.6	2.0	9.8	5.6
5a.	Public R and D expenditure 1969 per 10,000 u.a. of GNP	32.8	14.9	20.2	13.1	45.2	24.7
5b.	Ditto Community average = 100	133.0	60.0	82.0	53.0	183.0	100.0

[1] u.a. = European Monetary Agreement Unit of Account, 1 u.a. = 1 United States $.

SOURCE: Data collected by the Statistical Group, Statistical Office, European Communities.

Table 63. UNIVERSITY AND "HOGESCHOLEN" RESEARCH EXPENDITURE IN 1971

Millions of guilders

	CURRENT EXPENDITURE	CAPITAL EXPENDITURE	TOTAL
Social Sciences and Humanities			
- Law	13.5	1.1	14.6
- Economics	9.3	2.9	12.2
- Letters	27.8	4.1	31.9
- Social Sciences	22.9	4.1	27.0
- Others	11.2	5.1	16.3
Sub-total	84.7	17.3	102.0
Science and Medicine:			
- Medicine	77.8	17.3	95.1
- Dentistry	5.0	1.1	6.1
- Veterinary Science	7.3	0.4	7.7
- Mathematics and Physics	113.2	51.5	164.7
- Technical Sciences	88.7	32.3	121.0
Agricultural Sciences ..	21.5	10.1	31.6
Sub-total	313.5	112.7	426.2
TOTAL	398.2	130.0	528.2

SOURCE: Ministry of Education and Sciences.

In its most advanced forms research sometimes calls for an interdisciplinary approach which will not always tolerate the divisions and separations justified for teaching purposes. In addition, some research projects have come to demand such elaborate and costly equipment and special staff that the organisation and management is difficult, if not impossible, to fit into the system of the university. Then there is the equally important consideration that university research policy ought

Table 64. RESOURCES DEVOTED TO SCIENTIFIC RESEARCH CARRIED OUT BY UNIVERSITIES IN 1964, ACCORDING TO DISCIPLINE AND TYPE OF RESEARCH

	FUNDAMENTAL RESEARCH		APPLIED RESEARCH		DEVELOPMENT	
	THOUSAND OF GUILDERS	%	THOUSAND OF GUILDERS	%	THOUSAND OF GUILDERS	%
Mathematics and physics	62,200	85	7,700	11	3,000	4
Technical sciences	33,900	44	25,900	34	16,900	22
Medicine	42,900	53	25,700	32	11,800	15
Dentistry	1,000	29	1,800	51	700	20
Veterinary sciences	1,400	45	1,200	39	500	16
Agricultural sciences	6,100	65	2,700	29	600	6
TOTAL	147,500	60	65,000	26	33,500	14

SOURCE: CBS, Research and Development in the Netherlands in 1964.

Table 65. BREAKDOWN OF WORKING TIME OF THE SCIENTIFIC STAFF BY FACULTY AND ACTIVITY

FACULTY \ ACTIVITY	ESSENTIALLY TEACHING	ESSENTIALLY R AND D	MIXED TEACHING/ R AND D	ADMIN-ISTRATIVE WORK	ESSENTIALLY MEDICAL PRACTICE	MIXED MEDICAL PRACTICE/ TEACHING	MIXED MEDICAL PRACTICE/ R AND D	OTHER	TOTAL
A Sciences: total	35	25	13	10				17	100
- Law	35	26	12	16				17	100
- Economics	39	24	13	8				16	100
- Letters	35	27	12	9				17	100
- Social sciences	32	24	14	12				18	100
- Other faculties	32	27	13	9				19	100
B - Exact sciences: total	26	35	14	10				15	100
- Mathematics and natural science sciences	21	40	15	9				15	100
- Eng. sciences	31	28	14	11				16	100
- Agricultural sciences	26	34	14	10				16	100
C - Medical sciences: total	12	20	11	4	30	9	2	10	100
- Medicine	10	19	4	6	32	10	2	16	100
- Dentistry	29	16	10	8	17	7	1	12	100
- Veterinary science	20	25	13	8	9	10	2	13	100

SOURCE: Central Bureau voor de Statistiek, Mededelingen 7375.

to be dictated partly by what is being done by way of research outside the universities - in Government and other institutions, and to some extent even in industry - and that the work of the universities should be viewed as part of the total national R and D effort.

The University Education Act (1960) offered a number of leads for the formation of a university research policy. Permanent groups of members of university departments can be formed to prepare advice on the research policy to be pursued. In the broader context and ad hoc, working parties can be set up to carry out research projects. In addition to the faculty teaching committees, research committees can also be formed to help to bring about effective co-ordination of research programmes and promote optimal utilisation of new resources. However, insufficient use was made of the opportunities under the Act for formulating a university research policy. The reason for the absence of the structures needed for research policy was that up till then the universities had tried to give due weight to the increasingly tightening organisational requirements upon the basis of, in principle, unlimited autonomy of the scientists.

The University Administration (Reform) Act 1970 attempts to organise the universities along new lines. The Act provides for the following procedures with respect to university research policy.

At the lowest level, the teaching and research units (vakgroepen) and research groups (werkgroepen) draw up their research programmes and submit them for approval to the Faculty Council. Assisted by a standing research committee the Faculty Council reviews and compares the level and aims of the different programmes. Experts from outside the universities may be members of the committee, with or without voting rights. Their participation is especially important in evaluating large research projects. Each programme must be clearly formulated as to aims, manpower and financial implications. By carrying out progress control the Faculty Council will gain an idea of how the allocated credits are being spent and will be able to evaluate the results as they appear.

At the highest level within the university, the University Council co-ordinates the faculties' research programmes and the development of an integrated university research policy.

The university councils should co-operate in formulating an inter-university research policy for the Netherlands Universities Council. The latter is also responsible for integrating university research policy into national science policy.

Thus the University Administration (Reform) Act makes it easier for the universities to formulate long-term aims and establish more precise priorities in university research. It also allows them to programme actual projects with respect to duration, staff requirements and equipment.

In addition, the Act provides for the development of structures within the universities allowing progress control to be exercised on research projects in hand. In this way a better idea can be gained of how resources are being used.

The report "Developing improved planning for post-secondary education in the Netherlands" by McKinsey Management Consultants also deals with university research planning.

McKinsey's distinguish two categories: "education-related research" and "specialisation research". Education-related research is research undertaken as an integral part of the normal teaching of a discipline and is funded out of the budgets of post-secondary education institutions. Specialisation research, in contrast, includes research projects not necessarily related to the normal teaching in disciplines offered at post-secondary institutions. At present this type of research is funded both out of institutional budgets (mainly universities) and from sources outside the institutions, in other words from a "second flow of funds".

As regards the planning of resources required for education-related research McKinsey's recommended a planning process by:

"1. making policy decisions that allocate specific amounts of staff time to research as well as to instruction and administration, and,

"2. preparing action plans and budgets for the discipline in accordance with the division of staff time. Because such research is performed largely by the same staff that provides instruction, it cannot - and should not - be planned separately from the instructional activities of each discipline".

In discussions on these recommendations it was suggested that the permanent research committees of the faculties, to be set up under the University Administration (Reform) Act 1970, could be given the task evaluating and supervising the research programmes in the education-related category.

As regards specialisation research planning, the McKinsey report observes that projects in this category "should be judged on a project basis by appropriate bodies, and these projects should be included and clearly identified in discipline plan, and budgets". In the aforementioned discussions it was suggested that national specialisation research planning outside the pattern proposed by McKinsey's did not seem desirable.

Evaluation and supervision of these projects will, however, have to take place in a broader framework than that provided by the permanent research committees. To this end the committees could have a more widely representative membership.

Furthermore, the implementation of the proposals concerning the restructuring of university education put forward by the Government Commissioner for University Education, will also help to promote improved organisation of research activities at the universities. In a number of memoranda for discussion the Government Commissioner proposed that normal courses should be shortened while only the more academically gifted students would be permitted to continue their studies further. These students would be appointed by the universities as salaried research assistants, in which capacity they would have the opportunity for improving their skill as research workers. This would lead either to a doctorate or a special research qualification. The Act states emphatically that the allocation of such assistantships must fit in with national research policy. Distribution of the assistantships over the universities and over the faculties would have to be decided by inter-university consultation. The Act also suggests consideration of whether part of the second flow of funds might be used to finance the appointments.

In order that some understanding may be gained of the type of research undertaken at the universities more attention will have to be given to reporting on research in progress. It is nevertheless gratifying that a system of regular reporting has already been initiated. The universities' recent development plans state the research activities being, and about to be, undertaken, and much information can also be gained from the progress reports that the universities are annually required to present to the Minister. Moreover the Netherlands Organisation for the Advancement of Pure Research (ZWO) issues regular publications which review current research (mainly fundamental) in various fields both inside and outside the universities, while similar reviews are published by the Royal Netherlands Academy of Science on current research in social science.

Reports on research completed or in progress, contained in the universities' development plans and annual reports, also allow the responsible authorities to follow critically the progress of university research. Of course the research reports contained in the development plans are liable to become out of date quickly; nor do they give cost estimates. More thought will have to be devoted to the cost aspect in the next series of development plans. More co-ordination of development plans with the general financial schedule will make for greater consistency in university research planning.

3. INTER-UNIVERSITY CO-OPERATION AND DIVISION OF LABOUR

Inter-university co-operation and division of labour are closely associated.

The Government takes the view that policy in this regard must aim at achieving a balance between the two extremes of scarcity of resources on the one hand, calling for concentration and division of labour, and the diverse nature of research essential to its development on the other. But the general principles of efficiency must be observed if any development is to take place at all. One of the ways of achieving this objective is through inter-university co-operation and division of labour.

Optimal use of the universities' limited manpower and material resources by means of collaboration has, in the Minister's opinion, not yet been achieved.

In a 1968 report, the Netherlands Universities Council's General Committee on University Research explicitly confined its recommendations to those concerning internal university research policy, since it held the view that successful inter-university discussions presuppose a certain level of development in internal policy, partly because university institutions should have evolved the ability to recognise their own limits in order to be able to decide what they can do independently and what they must undertake in co-operation with other institutions.

In view of the situation to date, where the dire need for co-operation and division of labour among the parties concerned has not always been fully understood, future policy will have to put much more emphasis on concrete co-operation among the universities and "hogescholen".

One of the ways to bring about co-operation between the universities is to promote the establishment of inter-university institutes. The legal basis for the establishment of these institutes was provided by the University Education Act. They have the status of foundations (Stichtingen) and are subject to the approval of the Minister. Normally the institutes are not directly financed by the State but by contributions from the participating universities. Efforts are being made to achieve a certain division of labour among the university institutions. In its distribution policy the Government has made allowance for it wherever possible, both through the distribution of disciplines over the various university institutions and through its policy with respect to the allocation of chairs for the specialised subjects lending themselves to inter-university co-operation and/or division of labour.

Table 46. INTER-UNIVERSITY INSTITUTES

NAME	DATE OF CREATION[1]	AFFILIATED UNIVERSITIES[2]	NUMBER OF PERSONNEL			BUDGET (1971) IN GUILDERS
			SCIENTIFIC PERSONNEL	NON-SCIENTIFIC PERSONNEL	TOTAL PERSONNEL	
1. Radiopathology, Leiden	(1958)	L	35	69	104	4,395,000
2. Reactor Institute, Delft	1969	THD, THE, THT, L, G, U, VU, GU, KUN, MF, LHW and RCN, TNO, IKO	32	130	162	8,943,000
3. Institute for Social History	(1935) 1965	GU, VU, L	20	39.5	59.5	2,179,000
4. Institute for International Law, Den Haag	1965	L, G, U, GU, VU, KUN, NEH, KHT	16	14	30	1,068,000
5. SISWO, Amsterdam (social science research)	(1960) 1965	All universities	14	9	23	907,000
6. Netherlands Centre for Documentation for Law History, Amsterdam	1966	L, G, U, GU, VU, KUN, NEH, KHT	2	2	4	105,000
7. Missiology and Oecumenics, Utrecht and Leiden	1965	L, G, U, VU, KUN	6	2	8	366,300
8. Norms and Values, Rotterdam	1969	L, U, GU, VU, KUN, THD, THE, THT, NEH, KHT	8	7	15	455,000
9. Business Administration, Rotterdam	1971	THD, NEH, VU, L	37.33	14.60	51.93	1,207,000
10. Demographic Institute, Den Haag	1971	L, G, U, GU, VU, THD, NEH, KHT, LHW	2	4	6	155,000
11. Ophthalmological Institute, Amsterdam	1971	GU, VU, MF	8.5	8.5	17	700,000
12. International Institute for Advanced Studies, Wassenaar	1971	All universities	2	15	17	1,401,000

1. Dates in brackets indicate the date of the creation of the institute.
2. RCN: Reactor Centre Netherlands,
IKO: Institute for Nuclear Physics Research,
L stands for State University at Leyden,

G : State University at Groningen
U : State University at Utrecht
VU : Free University, Amsterdam
GU : Municipal University, Amsterdam

KUN: Catholic University, Nijmegen
THD: Technological University, Delft
THE: Technological University, Eindhoven
THT: Technological University, Twente

NEH: Netherlands School of Economics, Rotterdam
KHT: Catholic School of Economics, Tilburg
MF : Medical Faculty, Rotterdam
LHW: Agricultural University, Wageningen

The Netherlands Organisation for the Advancement of Pure Research (ZWO) and its affiliated institutions have up till now played a particularly important role in promoting co-operation and division of labour in university research, mainly through financing big facilities (accelerators in nuclear physics, for instance). ZWO, originally set up to lend support to new fundamental research ventures and co-ordinate research at the universities by providing grants, had to pay, recently, more to its other general task, viz. rendering assistance to university research generally; this is labouring under difficulties due to the large influx of students. The desire to co-ordinate university research has led to the foundation of what are known as ZWO affiliated institutions, some of which have their own institutes. They claim the greater part of ZWO's financial resources, and this has, over the last few years, increasingly hampered ZWO in its efforts to promote major new research projects. ZWO's co-ordinating influence is particularly strong in the field of physics, the Organisation for Fundamental Research on Matter (the main organisation affiliated to ZWO) being responsible for financing about 40% of all university research in this subject. This organisation has research groups which provide the framework for a system of intensive collaboration and division of labour for physicists working in the universities. The research groups are closely associated with several universities. Many of the research workers who belong to the ZWO organisations work in university institutions and are prepared to devote part of their time to university teaching in exchange for the research facilities offered them.

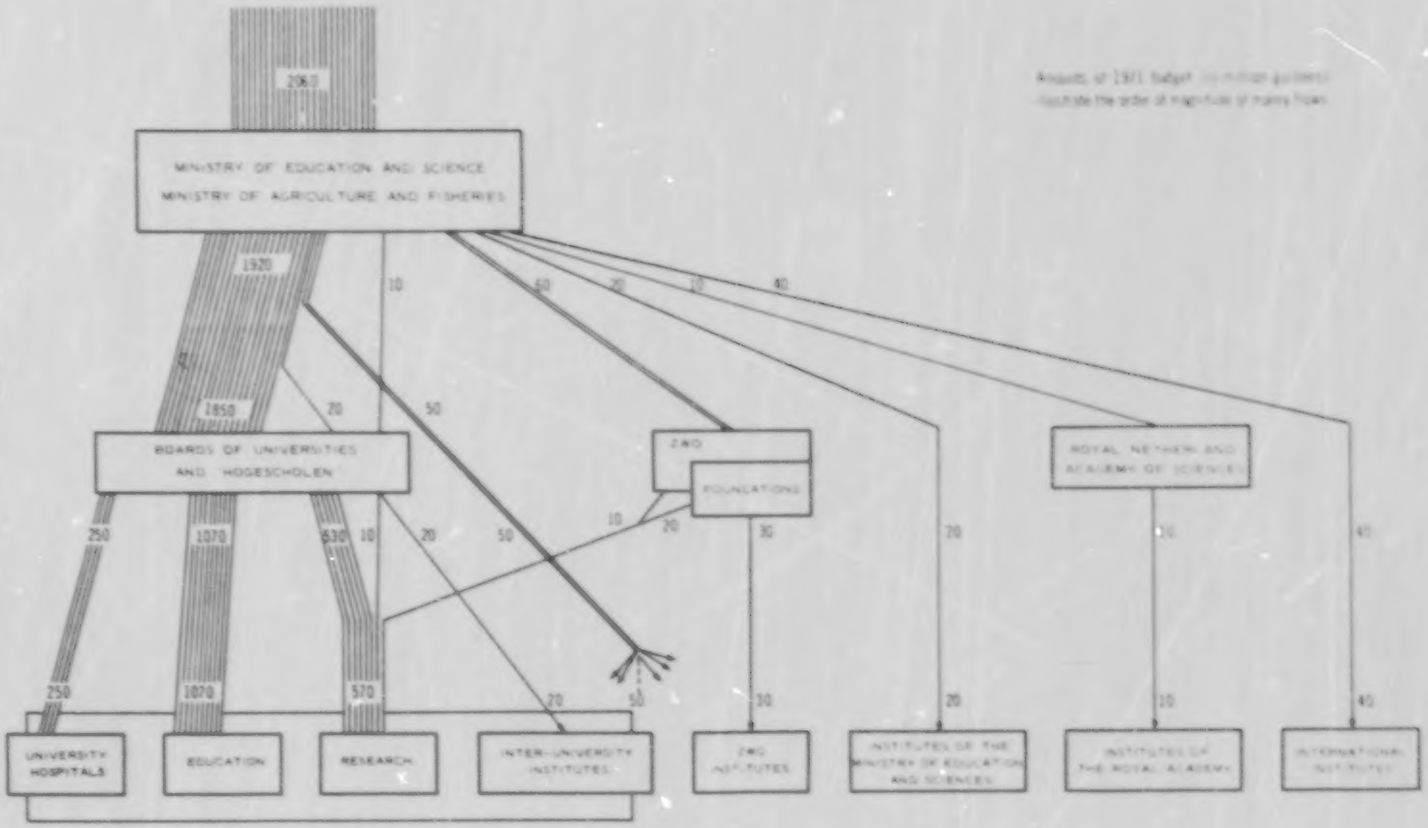
Some people think that it would seem desirable for the planning of university key research to be entrusted to a national external body such as an extended ZWO which would allocate key research in the various disciplines to every university institution, or, alternatively, would advise on it.

4. FINANCING UNIVERSITY RESEARCH

Closely connected with the above-mentioned problems of internal and inter-university research policy is the question of financial assistance from the Government. Apart from the budget item for research investment described above, the universities receive no separate appropriations for research. About 90% of university research is financed out of the universities' own budgets. The other 10% is financed by ZWO or its affiliated institutions, the Central Organisation for Applied Scientific Research in the Netherlands (TNO), and through research contracts. As has already been pointed out, internal and external flows of funds for university research are more evenly balanced in most other West European countries.

Chart 4

FINANCING OF SCIENTIFIC EDUCATION AND OF PURE SCIENTIFIC RESEARCH


2060
MINISTRY OF EDUCATION AND SCIENCE
MINISTRY OF AGRICULTURE AND FISHERIES
1920
10
60
20
10
40
1850
20
50
BOARDS OF UNIVERSITIES
AND HOGESCHOLEN
ZWO
FOUNDATIONS
ROYAL NETHERLAND
ACADEMY OF SCIENCES
250
1070
530
10
20
50
10
20
30
20
10
40
250
1070
570
20
50
30
20
10
40
UNIVERSITY HOSPITALS
EDUCATION
RESEARCH
INTER-UNIVERSITY INSTITUTES
ZWO INSTITUTES
INSTITUTES OF THE MINISTRY OF EDUCATION AND SCIENCES
INSTITUTES OF THE ROYAL ACADEMY
INTERNATIONAL INSTITUTES

Amounts of 1971 budget (in million guilders) illustrate the order of magnitude of many flows.

Sources: Science Policy Council.

The usual European scheme for financing research is to provide the university directly with funds for the totality of its needs for instruction, and to supplement the contribution for research in the sciences by separate mechanisms. This is the purpose of ZWO and partly of TNO.

ZWO has already on several occasions advocated that part of the ordinary university budgets earmarked for R and D should be transferred to its own fund to augment the second flow of funds. The Science Policy Council, believing that it would be a way of ensuring the continuance of university research, supported ZWO's arguments, and was later to advise the Government accordingly.

The Government, however, held the opinion that implementation of these suggestions was not desirable before the deliverance of the report of the Science Policy Council on the organisation and financing of university research.

In June 1971 the Science Policy Council gave some (preliminary) views on the most effective financing of university research in a report to the Government. The Council held the view that in the national science policy there should be a priority-schema.

Upon the basis of such a scheme it should be possible to establish focal points in the university research. The Council said that research should keep an important place in the universities for a good performance of their educational and teaching task. It is necessary that costly research projects should be evaluated in the light of criteria of a national science policy. The universities themselves should co-ordinate less costly research activities.

The Council holds the view that there does not exist sufficient insight in the annual expenditure on scientific research in the universities.

The Council is of the opinion that the Netherlands Organisation ZWO could improve the flexibility of its procedures in order to stimulate scientific research in new fields. Besides, the research paid out of the own university funds could be better co-ordinated with the research activities supported by ZWO through the establishment of a central research committee of 5 to 7 members in each university. These committees should be informed in all research projects carried out in their institutions.

The Preliminary Note of the Council has been published in order to stimulate further discussions on this subject in a wider context and to delineate the viewpoints of the various authorities concerned. The Minister for Science Policy has taken the initiative for deliberation with representatives of the science organisations concerned to create more effective structures for the organisation and financing of university research.

5. RELATIONSHIP BETWEEN UNIVERSITY AND INDUSTRY; CONTRACT RESEARCH

It is evident from the foregoing that the resources for university research not provided from the universities' own budgets are slender. Part of the reason for this is the small amount of contract research* carried out in the Netherlands though information as to the exact amount is not available.

One of the several reasons why there is no large-scale contract research in the Netherlands is the fact that industry may make use of the services provided by TNO, this organisation being geared to carrying out outside commissions.

Both the Government and the Science Policy Council consider the system of contract research very worthwhile. An involvement with developments in the community can give meaning to, and exert a productive influence on, research undertaken at the universities, which in its turn helps the community. In his memorandum on the development plans the Minister stated that he would like to encourage the universities to seek and accept research work on contract.

The proposed amendment, comprising a review of the regulations for financing State and independent universities and "hogescholen", opens up the possibility of leaving income from contract research partly or wholly out of consideration, in determining Government contributions to university finances, so that any income from this source would be additional to the universities' other income.

Despite the small amount of contract research in the Netherlands universities relations between the universities and industry may be said to be good. This is partly attributable to the fact that a considerable amount of fundamental research is undertaken by Netherlands industry. Many university professors and other academic staff act in an advisory capacity in industry, a considerable number of them having actually started their careers in industrial research. In addition, the Institution of Part-time Professors and Readers offers the opportunity of carrying out research at institutes or laboratories attached either to universities or industrial firms. More than 20% of all Dutch university professors are connected with non-university research in this way. By virtue of their dual responsibilities they are very well placed to improve relations between the universities and outside organisations, notably industry.

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* The term "contract research" is applied to scientific research carried out in the universities under a contract between the university and a sponsor. The arrangement is not confined to fundamental and applied research; the universities may also be asked to assist in the development of measuring instruments for research, for instance.

Relations are also improved by the "para-university" institutes which, though not forming a part of the university system, nevertheless maintain close ties with the universities.

Part Six

SCIENCE POLICY AND NATIONAL GOALS

"A nation that lives builds for the future". This inscription on the barrier dam of the Zuiderzee expresses pretty well one of the main features of the Netherlands community and one of its major concerns. The Zuiderzee closing project with the subsequent scheme for utilizing the newly reclaimed land is a particularly vivid example of long-range policy of interest not only for the area of regional planning but for society as a whole.

The idea of planning is one of those most frequently referred to by officials in all segments of government. So far however the term planning has been more or less closely identified with systematic forecasting of short-term trends rather than with an elaboration of binding guidelines for a given aspect of national existence.

It is now felt strongly that a more global approach is necessary for assessing the material and intellectual possibilities of the country against a set of long-term goals. Several attempts have been made at exploring possible developments of major functional capabilities - transport, regional planning, health, etc. - over the next two or three decades. This underlines the urgency of replacing the various components into a synthetical view of social futures which could help to improve decision-making and lead to a real programming of desirable actions.

To integrate scientific methods and results of research into the policy-making process a special working party of experts recommended the creation of a new central body called the Planning Council whose task would be to formulate an integrated long-term approach to social futures. This initiative could be an original method of coping with the new fundamental need for bringing scientific and technological research to bear on problems of social innovation.

I

TOWARDS GOAL-ORIENTED SCIENCE POLICY

In its progress report 1970, the Science Policy Council attempts a first assessment of its own action, the Government's policies during the years 1966 - 1969 and the size and utilisation of available research potential.

As far as the co-ordination of science policy is concerned the Science Policy Council is of the opinion that the Netherlands is still in a preliminary phase, though several important steps have been taken to integrate science policy into the framework of overall government policy.

In its first advisory report in March 1968 the Council indicated the main fields of science and technology to which increased funds should be given for the purposes of R and D. In its Progress Report in 1969 it retained these priorities and insisted further on an extension of the decision-making tools in order to facilitate advisable shifts of emphasis in the usual pattern of allocation.

In its progress report in 1970, the Council stressed that increasing attention should be given to a number of general problems arising, in particular, from the process, noticeable everywhere, of a rapid multiplication and intensification of human and social relations, mainly in three interacting fields: housing and living conditions, working climate and economic structure, communication and participation in social developments.

These remarks do not emphasise physical and technological aspects, which are already supposed to enjoy a widespread attention. When building up a decision-making philosophy in matters of scientific research major importance has to be laid on the capacity to construct an overall picture of the multiple inter-relations inside as well as outside the limits of the national society.

Problems of a modern society are closely connected with increasing tensions caused by the inequality of change and development in the field of what is called "welfare or well-being". More and more aspects of social life entail management of the environment. This requires a strongly co-ordinated and multi-disciplinary approach including both the natural sciences and the social sciences.

A national programme is urgently needed in this area and should be given priority. According to the Council, government policy will have to aim at co-operation between experts, whether they are employed by government institutions, the Organisation for Applied Scientific Research TNO, universities or industrial laboratories.

1. LATEST SCIENCE POLICY TOOLS

In its first generally advisory report in March 1968 the Science Policy Council recommended the following policy tools:

- a set of differentiated growth rates in order to facilitate relative shifts in the usual allocation pattern of R and D funds, in accordance with the Council's recommendations.

In its progress report 1969 the Science Policy Council mentioned the provisional character of the methods previously recommended and stated that "they should, at short notice, be replaced by a balanced system of assessment and control of government-financed R and D".

This recommendation was based on the assumption that shifts in the allocation pattern of R and D funds as recommended in the first report would henceforth be made merely as a consequence of the new budgetary approach to problems of R and D.

The Council insisted once more on the creation of a special R and D policy fund to create an opportunity for effectiveness and flexibility urgently required in the case of new developments. It was suggested at that time that this amount could also be made available to important non-university research institutions for innovative activity in the field of material equipment.

Finally, the Council also pleaded for an extension of the decision-making instruments by establishing so-called pilot or reviewing committees to review the state of the art and the prospects in various fields of R and D activity.

a) Differentiated growth rates

The method of differentiated growth rates for the various fields of scientific research and development was proposed as a means of correcting imbalances due to the very rapid progress of government expenditure on R and D before 1966.

It was thought important to implement these modifications of past trends on the basis of a "science budget", giving a coherent and detailed picture of all major items of expenditure without losing time by preparing a set of priorities in advance.

Although the Government has accepted the principle of differentiated growth rates it appeared that the numerical breakdown of the science budget was not always a suitable framework for practising this approach. The amounts allotted to R and D in the science budget are often determined by considerations valid for the whole operational area.

The Council stated that so far it has been of little use to compare the science budget for various years. Such a comparison raises the difficulty of a still-changing and subjective interpretation of what is to be considered as R and D activity. This definitional problem has led - in the last few years - to considerable modifications which might be unjustly ascribed to a genuine shift in the expenditure pattern.

b) Department expenditure groups

To clarify this issue departmental expenditure groups were added to the overall figures in the science budget for 1970. Each group consists of items including more than 70% of R and D activities.

The Government adopted a procedure for the adjustment of these groups in the budget preparation. R and D expenditure can now be judged on the basis of the Science Policy Council's advice both in relation to the functional appropriation and other expenditure by the ministry concerned.

This offers the possibility of shifts of emphasis among the various departmental budgets on the basis of overall science policy considerations in such a way that budgetary consequences can be linked to a set of priorities in the field of R and D.

In principle the double procedure by department expenditure groups and by functional appropriations is supposed to offer a possibility of coping with the well-known problem of the double relationship of most science policy expenditure, that is, the necessity for carrying out R and D activities outside the department while maintaining allegiance to the department's own work.

The Council is of the opinion that a new procedure is needed which would take into account science policy considerations during the phase of preparation of the budget. Otherwise, little result can be expected from the "weighting function" granted by the Government to the Science Policy Council on its establishment.

For this weighting function to be of real use it is necessary for all important R and D activities to be included in the decision-preparing process. The way in which departmental expenditure groups are now drafted makes this sometimes impossible. In the new setting, an example of this was the disappearance of a large part of the scientific research for the benefit of social development and physical planning, fields which are deemed quite essential for the years to come.

c) R and D Policy Fund

In its advisory report on the destination of the R and D policy fund for 1970 the Science Policy Council made some suggestion regarding the objectives and the balancing function of the R and D policy fund in general. Basically, this fund is intended to be used for all unforeseen projects and more particularly for multi-departmental ones. It is clear that its functioning will be effective only if a pluri-annual budget can be drafted for the expenditure in various sectors of R and D.

At present the R and D policy fund is called upon to ensure the funding of new inter-disciplinary projects of interest to more than one ministry, or to procure new equipment and facilities for important research institutions.

As it is impossible to adjust the entire expenditure pattern of the science budget by strongly differentiated growth rates, the Science Policy Council favours a considerable increase in the R and D policy fund. The reason is obvious: it would give the Government broader scope for immediate action in modifying the R and D expenditure pattern in accordance with requirements of general government policy.

d) Pilot committees

In its 1969 advisory report the Science Policy Council recommended the creation of pilot committees to examine the state of the art and the prospects of certain important areas of R and D. In the preliminary discussions on the task of these committees, emphasis was placed on obtaining deeper insight into R and D activities in a given area.

The first pilot committee was set up in 1970 to investigate the situation in the area of building construction research. Proposals for the creation of similar teams in other fields have been submitted to the Science Policy Council and the Government. However, an extension of this procedure has been postponed until the results of the first committee are known. The Science Policy Council expects positive effects from this experiment for the science policy of the Netherlands.

2. NEED FOR CO-ORDINATION

The subject of a co-ordinated and multi-disciplinary approach crops up in all discussions as one of the major issues in Netherlands science policy.

To cope with this problem a full utilisation of the available research potential seems to be a logical answer.

The Science Policy Council is of the opinion that it is the Government's task to formulate the main features of national programmes of multi-disciplinary and even multi-purpose character. In this way many isolated and sometimes arbitrarily dissociated activities could be stimulated and directed to new tasks.

This applies primarily to government agencies and government-sponsored research institutions. At the same time all segments of R and D activities outside the Government should be called upon, in particular the higher education sector, industrial laboratories, statistics and information flows.

a) Higher education sector

When expert knowledge is required, the existing national research potential in the higher education sector should be utilised in the first place. This sector is now in a state of flux, in need of reform and restructuring both from the administrative and educational points of view.

As far as research is concerned, a pre-condition of a more rational utilisation of existing capacity seems to be the adoption of modern management methods. It is difficult to see the principle of free choice of research subjects as the only criterion of research activities in this sector. It seems reasonable to expect that university researchers should be stimulated in the selection of their research programmes to pay attention to problems which concern society as a whole. This presupposes that the researcher is aware of his duty to society and that scientific research required at all levels should be formulated as explicitly as possible.

By an explicit description of the research objectives which appear to be underlying conditions for improving the country's national welfare it is hoped to obtain the co-operation of those researchers ofthe younger generation who prefer fundamental scientific research, not because of decided views but from aversion to applied research, advanced development, engineering and product design.

A possible example is the formation of project groups applying themselves to chemical and biological research with regard to well-defined aspects of environment management, as far as possible in multi-disciplinary co-operation with social scientists, economists and technicians.

b) Industrial research potential

In order to tap industrial R and D potential for social innovation, it would be useful to inform the principals of industrial research about problems faced by the Government concerning technical aspects of environment management, health, traffic and transport, communication, automation and other subjects of topical interest. They may have contacts which could bring relevant knowledge to the notice of the government agencies concerned. Further development of such knowledge, especially when it concerns research of only secondary importance from a purely commercial point of view, could be undertaken with government participation.

The nature of the required contacts between government and industry, is probably not suitable for institutionalisation. In line with the usual pragmatic approach these contacts are likely to be made on a personal level and on the basis of mutual interest.

As an example of this kind of co-operation the Science Policy Council indicates the collaboration between the Ministry of Social Affairs and Health, and Philips's Physics Laboratory on the development of a permanent measuring network in the Rhine Delta area for registering air pollution.

c) Statistics and information flows

Availability of factual data is important for the full utilisation of available research potential. In comparison with other countries the Netherlands possesses useful statistical material, but it only applies to the last few years. The Science Policy Council advises the following improvements:

- the research potential should be flexible enough to be adapted quickly to new tasks;

- the ability to discern imminent tasks at an early date should be gained by permanent analysis of the social structures utilising if necessary, a descriptive model drawn up for that purpose;
- the statistical work done should be widely published in order to inform researchers of the data available.

In the field of scientific and technical information one of the major concerns of the Science Policy Council is to make a substantial increase in allocations for projects designed to build up national and international systems ensuring a smooth, rapid flow of new knowledge.

3. FROM "FRAMES OF REFERENCE" TO SOCIETY OBJECTIVES

The main task of the Science Policy Council is to give independent advice to the Government on the development of governmental and industrial fundamental and applied research, their financial implications and their relationship to economic growth and other aspects of science and technology affecting society. The Council considers it particularly important to determine priorities in the field of science and technology in relation to other government objectives and to general goals.

For that purpose the Science Policy Council has attempted during the period of its mandate 1966-1971 to formulate a coherent system of leading principles, called "frames of reference", which should be taken into consideration when directives for science policy are being formulated.

These frames of reference reflect a number of goals accepted by the Netherlands society which are relevant to science policy in general and in their turn can be influenced by implications of science policy results. These goals are as follows:

Moral and cultural standard of living

- increased knowledge and insight,
- improved quality of scientific education,
- improved quality of education on all levels,
- decentralised provision for cultural needs.

Social living conditions

- social structures adapted to new needs,
- improved communication between various social levels,

- closer relations between citizens and institutions,
- a balanced legal order,
- improved social mobility.

Physical living conditions

- preservation of environmental hygiene,
- health care and protection,
- effective physical planning,
- adequate transport and communications network, housing.

Economic potential

- economic growth,
- equilibrium of the balance of payments,
- full and geographically-balanced employment.

Position of the Netherlands in the international life

- preservation of society in the Netherlands,
- maintenance of national prestige,
- development of international co-operation as a goal in itself,
- preservation of peace.

With respect to the allocation of R and D funds it is the opinion of the Science Policy Council that the Netherlands has to avoid scattering expenditure. The Netherlands is in general interested in the same scientific fields as France, Germany and the United Kingdom, but its professional population and its gross national product constitute only about one-fifth of the professional population and the gross national product of each of these countries. In such a context it is an urgent necessity for the Netherlands to make a choice of scientific research.

Consequently, available R and D funds should be used essentially for valid projects which meet the following requirements:

- high scientific quality;
- no imitation of projects already undertaken abroad;
- availability of competent direction;
- adequate size;
- sufficient contact with similar projects in the Netherlands or in Europe.

The Science Policy Council is considering the study of optimal relationship between fundamental research, applied research and development as one of its future tasks. In the case of the Netherlands, overall expenditure on R and D is strongly influenced by the important research activities of the Netherlands "big five" multi-national corporations. In fact, fundamental and applied research in industry is primarily concentrated in those fields of science which look like making most profit in the future. Therefore the Council has repeatedly drawn the attention of the Government to those fields of fundamental research of importance to, but not immediately correlated with those covered by, industry.

For this it is necessary to concentrate resources more intensely than at present. In the case of individual or small-team fundamental projects the judgement by peers seems to be a basic procedure and criterion. However, concerning large science research projects which will require a considerable part of the funds allocated for R and D, a decision must be taken by the Government. For the evaluation of these major projects, programmes should be produced in which the following elements are clearly analysed: accurate description of the objectives, manpower, funds necessary and estimated duration of research work.

However, if the R and D effort is to be incorporated into a long-range policy aimed at the realisation of priority national goals, the evaluation of R and D should be based on a more systematic judgement. In a continuous assessment such as this the following questions are to be considered:

- what contribution to the national benefit and prosperity is expected from a special item of government objective in the framework of long-range development ?
- what benefits for society can be expected from further research linked to this government objective?
- what relative progress may be expected from this research compared with research on other items of government objectives ?

According to its own analysis, the Science Policy Council has based its advice - during the five years of its first official mandate - on available statistics, roughly delineated frames of reference and tendencies discernible in the research disciplines and the formation of scientific manpower. More systematic analysis, such as has been suggested already must be defined more clearly before it can be implemented, otherwise than incidentally, from one case to another.

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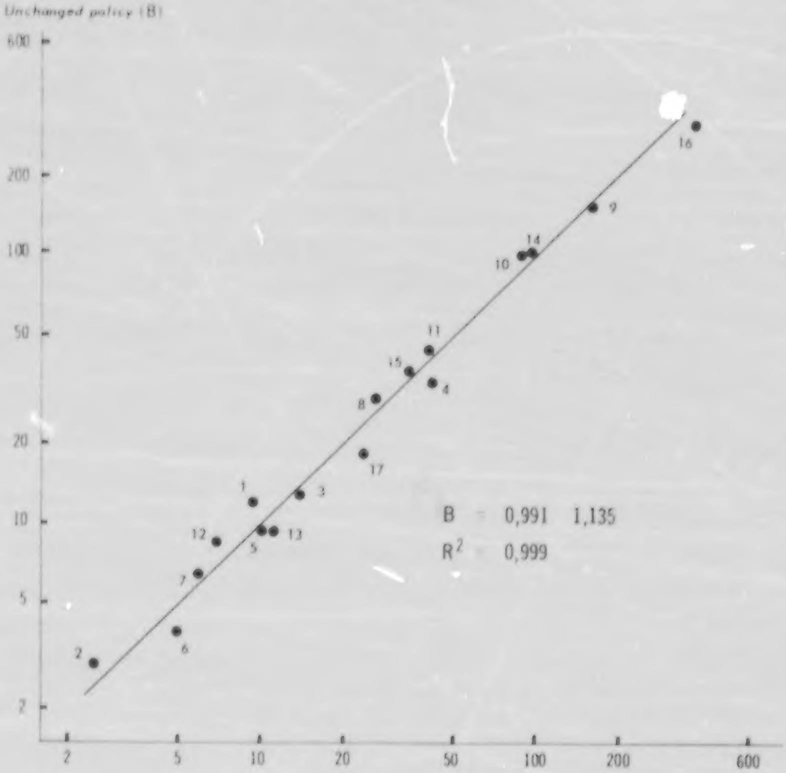
Graph 7

R & D EXPENDITURE IN 1971, ACCORDING TO FORESEEABLE TRENDS, EXCLUDING ANY CHANGE IN POLICY

(in millions of florins ; log. scale)



1. Aid and development
2. Justice and police
3. Education
4. Defence
5. Accommodation and construction
6. Physical planning service
7. Communications and transport
8. "Waterstaat"
9. Trade and industry
10. Agriculture and fisheries
11. Public health
12. Further education and related fields
13. Arts and history
14. Nuclear research
15. Space research
16. General science promotion
17. Not broken down

Is it possible to assess the impact of the Science Policy Council's activity on the pattern of the Government R and D expenditure? An attempt at a quantitative evaluation of this influence was made by the researchers of the Central Planning Office. *

This evaluation is based on a comparison between the figures suggested by the Council through its incremantal approach and those obtained by an extrapolation of past policy trends.

The underlying assumption was that if figures suggested by the Council were equal to foreseeable trends in the case of unchanged government policy, the latter would be acceptable and at the same time the advice of the Council would appear to be superflous. Conversely, if there were a clear divergency, government policy would be questionable.

As is shown in Graph 7, changes proposed for 1971 by the Science Policy Council appear as only marginal modifications. The differences between the unchanged policy magnitudes and the modifications suggested by the Council correspond, in the majority of cases, to only a few tenths per cent of the total government expenditure on R and D. The correlation between the two series is almost perfect.

However, this type of comparison must be interpreted with the utmost care. The Science Policy Council is still at the beginning of its existence and could not possibly formulate recommendations entailing profound structural changes. Furthermore, the available resources and the existing institutional set-up constitute serious constraints limiting the scope of the Council's influence. Notwithstanding, taken separately, the Council's recommendations sometimes imply important changes, particularly in the case of the hitherto somewhat neglected field of government R and D.

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* J. Passnier and R. Ruiter, Organisatie en planning van speur-en ontwikkelingswerk in Nederland, 9.4.1970.

II

SCIENCE POLICY WITHIN "INTEGRAL" PLANNING

I. FUNCTIONAL PLANNING APPROACHES

The particularly lively concern with planning and future research can be illustrated by the work of specific planning institutions such as the Central Planning Bureau in the field of economy, the National Physical Planning Agency in the area of regional and urban planning as well as by the long-term investigations carried out by the Ministry of Transport, Water Control and Public Works.

a) Central Planning Bureau

The major objectives of the Netherlands economic policy as formulated by the Social-Economic Council and endorsed by subsequent governments are:

- internal equilibrium, i.e. a high and stable level of employment;
- external equilibrium, so that the balance of payments - taking into account foreign aid - shows neither substantial surpluses nor deficits;
- a stable level of prices;
- an acceptable distribution of income, particularly with regard to labour and non-labour income;
- a stable and satisfactory rate of growth.

Since growth and the distribution of income appear among the policy objectives, medium-term planning seems to be a logical counterpart to annual planning. Nevertheless, although implicity borne by a medium-term view, short-term planning prevailed until the early sixties, the main reason being the reluctance of consecutive governments to interfere with private business decisions. In consequence the existing economic planning mechanism has been moulded by the needs of short-term planning.

The Government is responsible for formulating and carrying out short-term economic policy. The Central Planning Bureau has an important advisory and co-ordinating task in the preparation of this policy.

The Central Planning Bureau was provisionally founded in September 1945 and legalised by the Act of April 21, 1947. This Act states that the Central Planning Bureau's task is "to carry out all activities relating to the preparation of a central economic plan which at regular times shall be laid down by the Government". That is to say that the Bureau is responsible only for the forecasts of economic development and the effects of policy measures whereas the Governement bears the responsibility for the concrete policies and directives issued by the Plan.

The economic plans are to be accepted by a sub-committee of the Cabinet, the Council of Economic Affairs. Standing members are all ministers whose tasks have some direct bearing upon the economy. The remaining ministers have the right to attend meetings.

The second committee relevant to economic planning is the Central Economic Commission, an advisory body of the Cabinet. It consists exclusively of a number of top-level civil servants from the various ministries, one of the directors of the Central Bank and the Director of the Central Planning Bureau. This commission is consulted by the Government on major economic problems, especially those for which more than one minister bears responsibility.

By virtue of the 1947 Act the Central Planning Commission has been installed as an advisory body to the Cabinet and the Managing Board of the Central Planning Bureau. It is composed of representatives of the ministries, trade federations and trade unions and independent experts. This commission has 30 members. In practice, its main task is to review the drafts of the publications of the Central Planning Bureau.

In the whole planning mechanism an important role is played by the Central Bank, particularly in the monetary field, both where policy-making and the enforcement of policy decisions are concerned.

Of considerable interest for short-term planning and in the future very probably for medium-term planning, is the Social Economic Council. Established in accordance with the 1950 Act on Industrial Organisation, it is a tripartite body consisting of 45 members. One-third of these members are appointed by trade federations, one-third by trade unions, the remaining third by the Government. These "Crown members" are expected to take care of the interest of the economy as a whole.

The reporting institutions mentioned above base their advice and recommendations partly on the preparatory studies and analysis of the Central Planning Bureau. This does not necessarily imply identical conclusions and recommendations.

On the statistical level the Central Planning Bureau's contacts with the Central Bureau of Statistics are very intensive. The division of labour between the two organisations is simple: whereas the Central Bureau of Statistics assumes full responsibility for past data the Central Planning Bureau's responsibility concerns those for the future, except in the case of demographic forecasts, a domain belonging by tradition to the statistician.

Short-term forecasting constitutes a continuous process which can be summarised as follows:

Each annual plan is preceded by at least two others: an unpublished one in the spring and a published one in September - both of the preceding year. The more elaborate plan is published in January or February of the year for which the plan is made.

The spring report is a very preliminary one. It contains a diagnosis on the then prevailing conditions and a numerically elaborated but still sketchy outline of the situation expected for the following year. This outline is only used within the Government and serves as a background for policy-making in the next few months when the budget proposals are being prepared before submission to Parliament in September. Simultaneously, with the latter the preliminary version of the final plan is published. It takes into account the effects of the proposal policy measures that are submitted to Parliament.

The plan published in January-February of the next year takes into account the effect of the decisions reached in Parliament. In combination with the most probable development of the other exogeneous variables this leads to the forecast paper that usually coincides with the central alternative of the plan. Apart from these, alternatives are presented in many cases e.g. with respect to policy measures still under consideration.

During the fifties emphasis was on short-term economic planning but gradually the interest in growth and growth-promoting policies increased. In 1963 it was decided to institutionalise the activities with respect to medium term planning. The Central Planning Bureau has been given this task. As in the case of the annual forecasts it bears responsibility for the forecasts whereas political decisions are to be taken by the Cabinet.

The first medium-term plan spans the period 1965-1970. A revolving procedure will be applied for the subsequent plans. In order to assist the Bureau in its study of trends in the various sectors, a number of advisory working groups have been constituted. The members are selected from experts in private firms and trade unions. A senior official of the Bureau in charge of co-ordinating medium-term planning and another one specialised in the relevant field serve as chairman and secretary respectively. As yet, six working groups have been installed. It is expected that similar groups will be constituted for all major economic sectors.

The interdepartmental Central Economic Commission which in the past acted as an advisory body to the Cabinet mainly on short-term problems will now be requested to advise likewise in the medium-term field. More specifically it will give advice on the operational aspects of co-ordination of medium-term plans for the various governmental sectors.

Though medium-term planning is still in its infancy, it is likely that in the near future the Social Economic Council will advise on the alternative suggestions made by the Central Planning Bureau whereupon the Government will present a medium-term budget to Parliament.

The present Netherlands concept of planning leaves no room for Parliament either to approve, reject or amend a plan as published by the Central Planning Bureau. As far as short-term planning is concerned parliamentary discussions are focused on the Government's budget. The central economic plan is commented upon and discussed by the standing Economic Commission of the House of Representatives with the Minister of Economic Affairs and the Director of the Bureau. Theoretically, the discussions may result in a request to the Bureau to prepare another set of policy alternatives.

The same procedure will be followed for medium-term planning. However, it is possible that in future Parliament will claim a more prominent role in the formulation of policy alternatives.

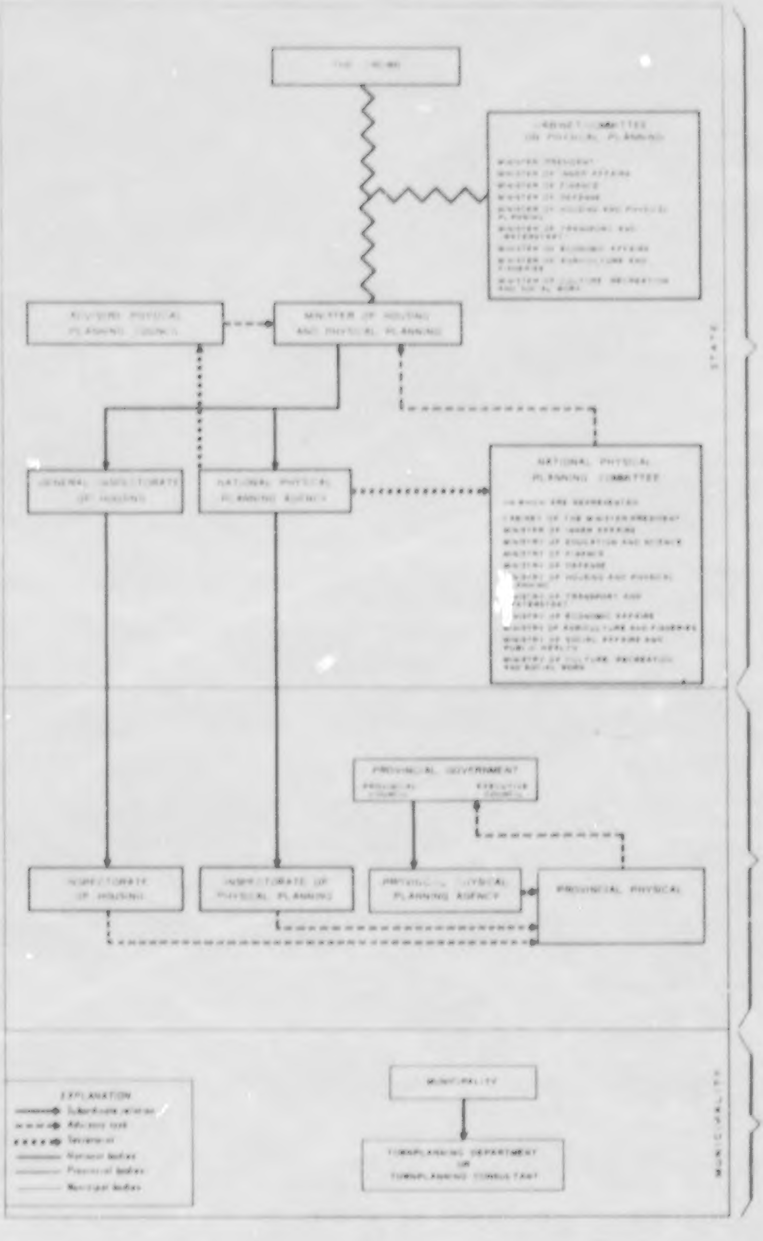
b) Organisation of physical planning

The purpose of physical planning is to promote physical development in such a way as to serve the well-being of the community and its individual members in the best possible manner. Physical planning does not try to achieve this by laying down rigid rules and by determining future developments in every detail.

It attempts to present a rough outline of a likely development. An example is the structural scheme for the year 2000 appended to the

CHART 5

PHYSICAL PLANNING INSTITUTIONS IN THE NETHERLANDS


THE CROWN
CABINET COMMITTEE ON PHYSICAL PLANNING
MINISTER PRESIDENT
MINISTER OF INNER AFFAIRS
MINISTER OF FINANCE
MINISTER OF DEFENSE
MINISTER OF HOUSING AND PHYSICAL PLANNING
MINISTER OF TRANSPORT AND WATERSTAAT
MINISTER OF ECONOMIC AFFAIRS
MINISTER OF AGRICULTURE AND FISHERIES
MINISTER OF CULTURE, RECREATION AND SOCIAL WORK
ADVISORY PHYSICAL PLANNING COUNCIL
MINISTER OF HOUSING AND PHYSICAL PLANNING
GENERAL INSPECTORATE OF HOUSING
NATIONAL PHYSICAL PLANNING AGENCY
NATIONAL PHYSICAL PLANNING COMMITTEE
IN WHICH ARE REPRESENTED
CABINET OF THE MINISTER PRESIDENT
MINISTRY OF INNER AFFAIRS
MINISTRY OF EDUCATION AND SCIENCE
MINISTRY OF FINANCE
MINISTRY OF DEFENSE
MINISTRY OF HOUSING AND PHYSICAL PLANNING
MINISTRY OF TRANSPORT AND WATERSTAAT
MINISTRY OF ECONOMIC AFFAIRS
MINISTRY OF AGRICULTURE AND FISHERIES
MINISTRY OF SOCIAL AFFAIRS AND PUBLIC HEALTH
MINISTRY OF CULTURE, RECREATION AND SOCIAL WORK
STATE
PROVINCIAL GOVERNMENT
PROVINCIAL COUNCIL
EXECUTIVE COUNCIL
INSPECTORATE OF HOUSING
INSPECTORATE OF PHYSICAL PLANNING
PROVINCIAL PHYSICAL PLANNING AGENCY
PROVINCIAL PHYSICAL
MUNICIPALITY
TOWNPLANNING DEPARTMENT OR TOWNPLANNING CONSULTANT
EXPLANATION
Subordinate relation
Advisory task
Secretariat
National bodies
Provincial bodies
Municipal bodies
MUNICIPALITY

second report on physical planning in the Netherlands. The object of this scheme was not merely to present the Government's views on the physical development of the country but also to initiate a broad discussion on this subject.

The overall picture presented in this report is moreover intended to be further elaborated by the provinces and municipalities. The outline of the physical pattern presented in the structural scheme is not intended as binding.

The physical planning institutions are articulated at three levels: national, provincial and municipal.

Physical planning at national level is to a large extent a matter of co-ordinating the various plans of the different ministries. In the first instance this co-ordination is in the hands of the Minister of Housing and Physical Planning. The respective ministers are responsible for implementation of the plans. The Minister of Housing and Physical Planning himself has only a limited executive task in the sphere of physical planning. He can grant subsidies for implementing urban reconstruction and redevelopment plans. He can also grant subsidies for projects intended to safeguard the open country between the cities, the so-called buffer zones.

Co-ordination at government level takes place in the National Physical Planning Committee on which all interested ministries are represented by leading officials while the Committee also includes two experts other than civil servants.

The National Physical Planning Committee deals with matters which may have important consequences in the sphere of physical planning. As a rule such matters are placed before the Committee by the Minister of Housing and Physical Planning and must be judged on their merits from the point of view of physical planning. Considering the large number of ministries represented on the National Physical Planning Committee it amounts to a continuous weighting of interests. This leads to a compromise which is not always necessarily the most desirable solution.

When the National Physical Planning Committee has submitted its recommendations to the Minister of Housing and Physical Planning the latter can, in reaching a decision, either adopt or reject them. In important cases he will place the recommendations of the Committee before the Cabinet Committee on Physical Planning.

The official body which assists the Minister of Housing and Physical Planning in formulating the national physical planning policy is the National Physical Planning Agency. This agency creates ideas and carries out investigations on behalf of the future physical development on the country. It acts as the secretariat for the National Physical Planning Committee and prepares the Committee's recommendations. All these matters are dealt with in consultation with the ministries involved and if necessary with the provinces and the municipalities as well.

At national level there is also the Advisory Physical Planning Council which was set up a few years ago. The Council, which has about 40 members, consists of representatives of all kinds of social organisations (workers, employers, recreation organisations, house-building corporations, transport organisation, etc.). Further, the Council members include a number of experts on specific aspects of physical planning as well as some provincial and municipal administrators. The Council can submit recommendations to the Minister of housing and Physical Planning, either at the request of the Minister or on its own initiative, on matters of general interest to the physical planning of the country.

At provincial level they are, more or less analogous to the National Physical Planning Committee, the Provincial Planning Committees which - as regards their composition - may differ somewhat from one province to another. The Provincial Physical Planning Committee submits recommendations in respect of physical planning matters to the Provincial Executive Council; the recommendations are officially prepared by the Provincial Physical Planning Agency.

At municipal level the Municipal Council is the administrative body which determines physical planning policy. For preparation of the plans the large municipalities have a town-planning department of their own, while the small municipalities usually avail themselves of the service of a private town-planning bureau for this purpose.

The municipal authorities play an important part in physical planning, since they draw up the allocation plans, i.e. the plans in which the future purpose of the municipal territory is laid down. This allocation plan is the only physical plan directly binding upon the citizen in the legal sense. For this reason the procedure that must be followed before the municipal plans acquire legal force is much more stringent that procedures for laying down structural and regional plans.

Structural plans are non-binding. They comprise a rough physical planning programme for a single municipality but often, as an intermunicipal structural plan, for a number of collaborating municipalities as well.

The provincial councils indicate the physical planning for their territory in one or more regional plans, not directly binding upon the citizen. It is a requirement however, that the municipal allocation plans must be in agreement with the rough outline of the regional plan. As the municipal allocations plans require the approval of the Provincial Executive Council the provincial authorities can, if necessary, withhold approval of a deviating allocation plan.

c) Ministry of Transport, Water Control and Public Works

In the field of transport, water control and public works, a working group instituted by the Ministry of Transport, Water Control and Public Works carried out an investigation of future prospects under the title "Towards the year 2000".

This study is considered as a preliminary approach to problems and matters that cannot be dealt with at short notice. It is not meant therefore as a reflection of a detailed cabinet policy and still less as a definite plan. In composing it, efforts have been made not to impinge on the domains of other ministries.

According to this series of projections, the need for transport is expected to increase considerably. This is the result of the population growth, the increase in national income and income per head of the population. An excessive dissemination of the population and a resulting splitting-up of rural areas into small fragments will have to be prevented. The development of telecommunications will replace movements increasingly. Nevertheless it will probably only have a slight effect on the growth of the number of real movements.

As to the traffic and transport problems within the cities, in many cases it will not be possible to adapt the physical structure of city centres to an unrestricted use of private cars. There is a development towards a selective use of cars in city centres. This is subject to the condition that a fully adequate alternative must first be created : a reliable, comfortable public transport system with sufficient frequency.

International traffic and transport policies will be characterised by the year 2000 by close co-operation within a larger European Community. It is to be expected that inland shipping will have to bear part of the costs of the waterways. For ocean shipping, an active government policy is considered a future necessity, to safeguard a maximum liberalisation in international shipping. As regards aviation, the Netherlands policy will have to aim at averting the restrictive tendencies abroad. The possibilities offered by co-operation between airlines will have to be utilised as fully as possible.

In the area of water control and land reclamation investigations and studies on a much larger scale that at present have to be initiated in order to gain an insight into the nature and scope of air pollution and its meteorological consequences.

The strongly increasing capacity of power stations will require, in international consultation, an efficient division of the total cooling capacity of the countries involved. The large-scale production of desalted water at a reasonable cost price still calls for extensive research.

The reclaimed land will considerably reduce land shortage in the Netherlands. The Isselmeer polders are of great importance in this connection because they are located near the "Randstad". Through the lack of any historical town centres in the southern Isselmeer polders, future-oriented urbanisation plans will have to be developed here rather than anywhere else. If necessary it may be possible to reclaim land from the North Sea in the distant future.

The future development of seaports will have to be based on comprehensive studies quantifying and weighing against each other the social and economic advantages and disadvantages of alternative seaport developments and their consequences with regard to physical structure planning. In cases where the establishment of industry in the Waterweg area is not absolutely necessary, constant efforts will be made towards creating attractive facilities for establishment elsewhere in the country.

There is every sign that the construction of national highways and the provisions to be made in the towns in the years to come will absorb the major part of government funds intended for improvement of the infra-structure. However, the capacity of a present and future roads cannot be increased indefinitely. In a further-off future electronic guidance of motor vehicles may provide a solution, because it permits a considerable reduction of the distances between vehicles without jeopardising safety on the roads.

The airports Schiphol, Rotterdam, Eelde and Zuid-Limburg supplemented by Eindhoven and Twnethe, will be able to handle air traffic for the next years. Schiphol will retain its central function. A stronger interelation will develop increasingly between the airports.

A radically new piece of infrastructure making itself known at the moment and expected to develop strongly in the coming decades is formed by pipe-line and cable corridors.

In general terms, this study insists on operational aspects. However the necessity for scientific assistance is stressed in every special field. To cope with underlying R and D problems a broader multi-disciplinary and multi-departmental approach is advocated.

2. "INTEGRAL" PLANNING OF SOCIETY'S FUTURES

Given growing government demand for research in the area of social sciences the Social Science Council has been giving priority, since the beginning of the sixties, to the study of possible contributions by social sciences to pending and future problems of the Netherlands society.

To undertake as comprehensive an analysis as possible the Council established a special working party (Contactcommissie Overheid/Social Wetenschappelijke Raad) composed of scientists on the one hand and senior government officials on the other.

The working group delivered a report in 1965 that met with considerable attention. In its comment on the conclusions of this report the Social Science Council stressed the necessity for stimulating and organising all types of social science research. According to its thesis, the government authorities have the task of ensuring sufficent financial support for this research and co-ordinating applied research on behalf of policy-making bodies by establishing a State Institute for Social Science Research.

Both the report of the working party and the comments of the Social Science Council stimulated lively discussion on government policy, planning and scientific research. This ledto the creation by the Minister of Education and Sciences in April 1968, of a Committee for the Preparation of Research on the Future Structure of Society entrusted with the task of bringing forward proposals on the institutional organisation of research to provide a basis for an integrated governmental long-term policy. The Committee was asked to take into account the activities of existing institutions working in the field of planning and to endeavour to draft an organisational pattern without creating special new bodies.

This Committee, composed of representatives of the existing planning bodies, of several ministerial departments and independent scientists, published its report in 1970.

It concluded that the activities of existing institutions for sectoral and functional planning are insufficiently co-ordinated and integrated, because of a lack of an overall understanding of the long-term development of society as a whole.

Aware of this lack the Committee recommended the establishment of a Planning Council (Raad voor de Planning) to be charged with investigating long-term social developments. This Council should advise a special ministerial Planning Committee on alternative long-term possibilities. A new body, the Office of Social Planning, to be created, should assist the Planning Council to carry out the necessary scientific research. This does not mean, according to the Committee's recommendations, that the existing institutions engaged in research and planning should discontinue their activities.

The Commission's proposals can be summarised as follows:

1. It will be necessary to establish a Planning Council whose task will be to make known the long-term trends in society as a whole - and in some of its sectors - as part of the scientific preparation of the authorities' general long-term policy. On this basis, the Council will give the authorities its opinion on the different long-term options for policy. The Council will be able, by supervising all the trends and their inter-relationship to counterbalance the unilateral and specialised viewpoints of existing consultative bodies. The Council will need to call on the knowledge of third parties, the results of scientific research carried out elsewhere, and institutions active in the field of planning by sectors and by functions. The Council will have to detect shortcomings in the knowledge, the scientific research and both forms of planning, and propose improvements. Furthermore, to ensure the scientific preparation of long-term policy, the Council will have to see that there are sufficient lateral contacts between the various planning institutions and that accurate demarcation of tasks and proper co-ordination are effected. The results of the Council's work will be published.

2. The Council will ultimately have 6 or 7 members appointed by the Government. The primary activity of these members will be their work on the Council. The hard task before the Council and the high standards expected of its members will entail a period of adaptation. During this time some members may be able to spare only part of their time for their work on the Council. The first phase should also make it possible to adjust, if necessary, the structure of the Council according to experience acquired. The directors of the Central Planning Bureau, the National Service for Physical Planning and the Central Bureau of Statistics together with the director of the Office of Social Planning, mentioned hereinafter, will be appointed extraordinary members ex officio. The appointment of the Chairman of the Science Policy Council as an extraordinary member should be considered.

3. The Council will have a staff of 15 to 20 who will prepare its activities. They will be appointed progressively.

4. The ministries and public bodies will provide the Council with all the information it needs to discharges its duties properly.

5. The establishment of a Planning Committee (at ministerial level) is necessary in order to make the Council's activities as effective

as possible. Given the responsibilities of the Committee, all ministries ought to attend its meetings.

6. It may be desirable to appoint a government representative (e.g. a Secretary of State) whose task will be to promote the analysis of government policy and its implementation in the light of knowledge acquired by the Government concerning social trends.

7. As the Council will be taking part in formulating the broad lines of long-term policy both for the Government as a whole and for the different ministries, it should be attached to the Ministry of General Affairs.

8. It would be desirable to set up an interministerial advisory body for long-term planning. This body could be one of the channels through which information from the ministries would pass to the Planning Committee and, conversely, through which the Council could pass its views on to the ministries. Another task of the interministerial advisory body would be to prepare the meetings of the Planning Council and see that the relevant activities of the ministries are co-ordinated.

9. In view of the function of the Planning Council, great attention will have to be paid to questions of publicity, as well as to contacts with society and its participation. The views of the Council can be adequately propagated by the publication of reports and use of modern communication media. Society may voice its criticisms of these ideas through the same media. This free exchange of views between the Council and society is currently the most suitable method of meeting the requirements of publicity, communication and consultation. Support may be expected from private institutes of futurology, which will also have a counter-balancing effect. It is difficult to judge whether the consultation process can be given a more institutionalised form. There is a lack of socially-based organisations in the field which the Planning Council will be covering, so that it will be difficult to arrive at an equivalent of what the Economic and Social Council is in its particular field. Practice will show whether it is necessary to set up in a sufficiently institutionalised form an advisory group of interested parties to counterbalance the Council. This means that the problem will have to be reconsidered when the Council has been in operation for some time.

10. The Planning Council cannot function efficiently without adequate scientific preparation of policy in the different fields. This is lacking in the field of social and cultural welfare, which has become one of the chief concerns of the authorities. An Office of Social Planning will have to be assigned this responsibility as soon as possible.

11. The membership and organisation of the office of Social Planning can be similar to that of the Service for Physical Planning and the

Central Planning Bureau. The inadequacies of socio-scientific research - and particularly macro-research - and the shortage of experts in this field make it essential to establish the Office of Social Planning by stages.

12. The Office of Social Planning will not make existing scientific institutes redundant nor the ministerial departments of research and planning. The Office should, like other planning offices, provide a framework within which the institutes can conduct better-oriented scientific research and the ministerial services carry out more efficiently and judiciously the practical preparation of each ministry's policy. It will be necessary to consider, however, the extent to which the institutes, ministerial departments, councils and consultative bodies will be able in future to improve the conduct of their activities within the Office of Social Planning or in association with it.

13. With the aid of empirical data and using its knowledge of interrelationships, the Office of Social Planning will have to clarify, from both the quantitative and qualitative standpoints, the socio-cultural aspect of autonomous trends and of the various welfare policies. On that basis it will advise the Government and the different ministries on practical assignments and policy measures, and submit alternative options. This will involve scientific investigation and recommendations to official bodies on questions relating to:

- the status of different social groups such as workers, women, young people, elderly persons, handicapped persons, the middle classes, farmers, etc.
- trends in standards and values: as for instance authority in the family, relations between business firms and the State, relations between the generations, changes within the family and changes in patterns of authority, re-evaluation of such phenomena as work and recreation, sexual expression, dissent, frustration, division of power, etc.
- the functioning and impact of major social institutions such as marriage, education, sport, hygiene, social welfare, social measures and their administrative background.

14. The Office of Social Planning will not deal with questions relating to the policy in the different sectors of social welfare. Medical research and teaching, in particular, will be outside the competence of the office. The Office of Social Planning will however supply the overall socio-cultural framework for medical, educational and other measures and activities considered from both the quantitative and qualitative standpoints. Medicine and education seen as social phenomena come within its field of responsibility, but neither of these disciplines as a whole.

15. The Office of Social Planning can only partly fill the present gaps in socio-economic research. Furthermore, it will have, like the other more specialised planning offices, to refer to scientific research done elsewhere. For this reason, one of the first tasks of the Office of Social Planning will be to organise socio-scientific research, in co-operation with the Social Council of the Netherlands Royal Academy of Sciences and the Planning Council and, of course, with the participation of the bodies which co-ordinate and implement such research.

16. The Office of Social Planning could exchange views with society through reports and annual statements of progress, the press and modern communications media; this would meet the requirements of publicity, communication and consultation. It is difficult to tell at this stage whether it will be possible to give the consultation process a more institutionalised form. There are too few organisations with a sufficiently social basis to act as the equivalent of the Economic and Social Council in the field to be covered by the Office of Social Planning. It is too early to say whether it would be advisable to set up a consultative group composed of interested parties to act as a partner of the Office of Social Planning.

17. It will be necessary to set up a Social Planning Committee (with a similar function to that of the Physical Planning Committee and the Central Planning Committee) to promote the co-ordinating function of the Office of Social Planning and give a more institutionalised form to contacts with representatives of the Government and scientific circles. Furthermore, regular consultations with the ministers most concerned will be necessary to ensure co-ordination of policy in regard to social and cultural welfare.

18. The Office of Social Planning has, like the other planning offices, a major task to fulfil in the scientific preparation of the policies of, theoretically, all ministries. Consequently it has to be attached to the Ministry for General Affairs. This is especially necessary since care must be taken from the outset to see that no one ministry exercises a decisive influence over the activities of the Office of Social Planning.

In the beginning of 1971 a committee established in December by the Prime Minister to advise on interdepartmental division of tasks and co-ordination in view of the new cabinet formation, published a report in which it expresses its views with respect to integral planning of society's future, based upon the consideration of the Social Science Council and the Committee for the Preparation of Research on the future Structure of Society. The Committee proposes the creation of a Scientific Council for Government Policy with a threefold task:

a) the drafting of a vision of the future of society on behalf of the policy in the long term;

b) to indicate the problem areas for which it is necessary - because of future needs - to establish priorities;

c) to co-ordinate the scientific bureaus of the Government, in order to indicate duplications and fill gaps.

Because the activities of the Scientific Council, to be composed of scientists from different disciplines, should relate directly to the policy-setting of the Council of Ministers, the Committee advised that the Prime Minister should bear the responsibility for the Scientific Council and that it should be attached to the Ministry of General Affairs.

The activities of the Council should be based on data from the main study and policy agencies, either already in existence or to be created for certain sectors of government policy. In the opinion of the Committee it is desirable that the Director of the Central Planning Bureau and the Director of the Physical Planning Bureau should be appointed advisors to the Council. At the same time a clear contact should be established with the Science Policy Council.

In line with the recommendations of the Committee's Interdepartmental Division of Tasks and Co-ordination the new government has decided to set up a Scientific Council for Government Policy under the Prime Minister, to be composed of five to seven persons of high qualifications, appointed for five years. The Council will be charged with the task of providing the data from which, for the future, the outlines of government policy could be set with a greater degree of certainty.

STATISTICAL ANNEX

INTRODUCTION

The following tables contain the main results of a survey on R and D in the Netherlands in 1969, carried out by the Netherlands Central Bureau of Statistics. The figures can be compared with most of those in similar tables of this report, but may be different in details.

The results for the higher education sector are based on an investigation into the allocation of time of the university staffs. They are therefore approxiamtions and are not as detailed as those of the other sectors. For the business enterprise sector data exclude enterprises with less than 50 employees. No data are available in this sector on R and D in the social sciences and humanities.

Table A-1. EXACT AND NATURAL SCIENCES¹

Personnel involved in R and D in 1969 by sector and level of occupation

	SCIENTISTS AND ENGINEERS			OTHER PERSONNEL			TOTAL		
	a	b	c	a	b	c	a	b	c
BUSINESS ENTERPRISES									
TOTAL	4,955	556	5,241	26,842	2,226	27,568	31,797	3,096	32,829 (611)
of which:									
Metal industries	2,223	166	2,246	15,560	796	15,826	17,783	962	18,111
Chemical industries	1,684	91	1,717	7,822	187	7,994	9,506	278	9,681
Food, drink, tobacco ...	417	87	439	1,555	138	1,608	1,972	225	2,047
Other manufacturing and mining	264	167	319	728	263	833	992	430	1,152
Non-manufacturing	165	347	481	1,167	811	1,437	1,332	1,158	1,918
RESEARCH INSTITUTES									
TOTAL	2,519	785	2,912	8,948	2,118	10,087	11,467	2,903	12,999 (24¹)
of which:									
Institutes mainly working for business enterpr.	140	59	193	596	65	622	736	156	937
Government institutes ..	316	297	452	948	1,170	1,521	1,278	1,467	1,965
Semi-governmental inst. ..	1,139	234	1,296	3,366	681	3,656	4,509	915	4,576
TNO	663	32	686	3,944	116	3,931	4,927	148	4,190
Institutes linked to universities	66	19	68	174	6	176	236	25	247
Other institutes	138	103	211	725	186	793	896	292	986
UNIVERSITIES TOTAL ...	–	–	2,916	–	–	5,399	–	–	8,316 (107)
of which:									
Mathematics and Natural sciences	–	–	1,330	–	–	1,570	–	–	2,900
Technical sciences	–	–	690	–	–	1,260	–	–	1,950
Medical sciences	–	–	890	–	–	2,230	–	–	3,120
Agricultural sciences ...	–	–	206	–	–	440	–	–	646
TOTAL	–	–	10,962	–	–	43,053	–	–	54,016 (1007)

1. Including part of personnel of teaching hospitals.

a = full-time.

b = part-time.

c = full-time equivalents.

SOURCE: Netherlands Central Bureau of Statistics.

Comments: – The share of scientists and engineers in total (a and c) personnel (percentage) per sector is:
in the business enterprise sector [illegible]%,
in the research institutes sector [illegible]% and
in the universities sector [illegible] 34%.
– Due to the method of investigation only full-time equivalents can be given for the universities sector.

Table A-2. INTRAMURAL EXPENDITURE FOR R AND D IN 1969 BY SECTOR AND TYPE OF COST

Millions of guilders

	LABOUR COST		OTHER CURRENT COST[1]		CAPITAL EXPENDITURE		TOTAL	
BUSINESS ENTERPRISES TOTAL	749,8		400,6		146,0		1,296,6	
of which:								
Metal industries		408,1		212,6		52,6		675,5
Chemical industries		219,4		128,8		66,5		413,7
Food, drink, tobacco		47,5		22,1		16,3		85,9
Other manufacturing and mining		24,5		15,2		6,1		45,8
Non-manufacturing		44,5		28,6		9,9		76,3
RESEARCH INSTITUTES TOTAL	268,9		107,2		77,8		453,9	
of which:								
Institutes mainly serving business enterprises		18,8		4,8		3,7		26,7
Government institutes		40,9		11,9		20,5		63,6
Semi-government institutes		100,8		43,1		33,9		177,9
TNO		78,8		33,5		36,6		148,9
Institutes linked to universities		6,8		2,1		0,7		9,6
Other institutes		23,9		7,8		3,5		35,1
UNIVERSITIES TOTAL	165,0		89,0		101,0		355,0	
of which:								
Mathematics and natural sciences		65,0		24,0		38,0		129,0
Technical sciences		34,0		18,0		29,0		106,0
Medical sciences		50,0		43,0		30,0		124,0
Agricultural sciences		15,0		4,0		4,0		24,0
TOTAL	1,208,4		594,8		325,2		2,128,4	

1) Including part of deficit of teaching hospitals.

Comments:
1. Whereas 61% of total intramural expenditure for R and D was spent in business enterprises, the share of capital expenditure for R and D is remarkably lower: 45%.
2. 11% of total R and D expenditure in the business-enterprise sector was capital expenditure, which means a decrease of 4% compared to 1967.
3. R and D in the business enterprise sector is mainly concentrated in the metal and chemical industries (83% of total expenditure). Moreover a very large part of this was spent by a small number of big companies.
4. Metal industries are – as far as R and D is concerned – rather labour-intensive: labour cost is 61% of total, against 53% in the chemical industries. Chemical industries can be qualified as capital intensive: capital expenditure 16% of total, against 7% in the metal industries.

SOURCE: Netherlands Central Bureau of Statistics.

Table A-2a. INTRAMURAL EXPENDITURE BY SECTOR AND TYPE OF ACTIVITY

Percentages

	BASIC + APPLIED RESEARCH		DEVELOPMENT	
BUSINESS ENTERPRISES	29		71	
of which:				
Metal industries		20		80
Chemical industries		43		57
Food, drink, tobacco		36		64
Other manufacturing and mining		29		71
Non-manufacturing		32		68
RESEARCH INSTITUTES	73		27	
UNIVERSITIES	85		15	
TOTAL	47		53	

Comments:

1. Total R and D expenditure is almost equally divided between basic + applied research and development.
2. In the business enterprise sector the ratio research: development is roughly the opposite of that in the other sectors.
3. Again there is a remarkable difference between the metal industries and the chemical industries: In the metal industries development strongly prevails; the chemical industries spend more on basic + applied research.

SOURCE: Netherlands Central Bureau of Statistics.

Table A-3. RESEARCH INSTITUTES

Personnel and expenditure by objective

	PERSONNEL		EXPENDITURE	
	(FULL-TIME EQUIVALENTS)	%	(MILLION GUILDERS)	%
Nuclear research	1,160	9.0	53.8	11.9
Space	586	4.5	22.9	5.0
Defence	788	6.1	29.7	6.6
Soil, sea and atmosphere	323	2.5	12.0	2.6
Health	1,768	13.7	58.4	12.9
Infrastructure	766	5.9	21.9	4.8
Agronomy	2,746	21.3	89.0	19.7
Industrial technology	2,053	15.9	59.3	13.1
Miscellaneous and unknown (incl. basic research)	2,729	21.1	105.8	23.4
TOTAL	12,919	100.0	452.8	100.0

Comments: 1. Objectives are only known for the sector research institutes.

2. The most important objectives are health, agronomy and industrial technology; nearly one quarter of R and D could not be classified by objective; a very large part of this quarter was basic research.

SOURCE: Netherlands Central Bureau of Statistics.

Table A-4. FINANCING OF R AND D - 1969

	BUSINESS ENTERPRISES	INSTITUTES MAINLY SERVING BUSINESS ENTERPRISES	UNIVERSITIES[1]	GOVERNMENT INSTITUTES	SEMI-GOVERNMENT INSTITUTES	TNO	OTHER INSTITUTES	NOT INCLUDED IN SURVEY		TOTAL
								NETHERLANDS[2]	ABROAD	
PRIMARY SOURCES										
Own funds	1,310.3	2.5	-	-	2.2	2.2	6.0			1,323.2
Government	60.8	-	374.8	85.2	176.2	116.7	17.1			830.8
Not included in survey:										
Netherlands[2]	-	3.5	-	0.2	2.5	6.0	-			12.2
Abroad	9.8	7.6	2.0	0.1	11.9	4.1	5.4			40.9
TOTAL PRIMARY SOURCES	1,380.9	13.6	376.8	85.5	192.8	129.0	28.5			2,207.1
TRANSFERRED FUNDS:										
Business enterprises		7.0	2.0	1.0	7.1	14.0	3.0	3.0	57.2	94.3
of which:										
Metal industries		2.4	1.0	0.5	2.3	6.8	0.7	1.5	41.9	57.1
Chemical industries		0.5	0.7	0.1	0.6	3.3	0.8	0.1	7.2	13.3
Food, drink, tobacco		0.9	0.1	0.0	0.7	0.9	0.2	0.0	1.0	3.8
Other manufacturing and mining		1.4	0.1	0.1	0.3	2.0	0.1	1.4	5.3	10.6
Non-manufacturing		1.8	0.1	0.3	3.2	1.0	1.4	-	1.8	9.6
Institutes mainly serving business enterprises	0.6		-	-	0.3	4.3	0.2	-	5.3	10.7
Government institutes	1.2	8.3	-		9.0	3.2	-	2.0	0.0	23.7
Semi-government institutes	8.0	0.1	1.0	0.6		1.3	7.6	15.2	0.4	34.2
TNO	-	0.2	-	-	2.7		0.5			3.4
Other institutes	-	0.2	-	-	0.2	0.5		1.8	2.0	4.7
TOTAL TRANSFERRED FUNDS	9.8	15.8	3.0	1.6	19.3	23.3	11.3	22.0	64.9	
TOTAL PRIMARY SOURCES + TRANSFERRED FUNDS	1,390.7	29.4	379.8	87.1	212.1	152.3	39.8	22.0	64.9	
MINUS: SELF TRANSFERRED FUNDS	94.3	10.7	-	23.7	34.2	3.4	4.7	-	-	
REMAINS: INTRAMURAL R AND D	1,296.4	18.7	379.8	63.4	177.9	148.9	35.1	22.0	64.9	2,207.1

1. Including institutes linked to universities.
2. Including enterprises with less than 10 employees.

SOURCE: Netherlands Central Bureau of Statistics.

Table A-5. SOCIAL SCIENCES AND HUMANITIES

Personnel involved in R and D in 1969 by sector and level of occupation

	SCIENTISTS			OTHER PERSONNEL			TOTAL		
	a	b	c	a	b	c	a	b	c
Business enterprises	.	.	.	.	.	.	.	.	.
Research institutes ..	592	354	769	1,087	437	1,305	1,679	791	2,074
Universities ..	.	.	1,020	.	.	430	.	.	1,450
TOTAL	.	.	1,789	.	.	1,735	.	.	3,524

a = full-time,
b = part-time,
c = full-time equivalents,

Table A-6. INTRAMURAL EXPENDITURE FOR R AND D IN 1969 BY SECTOR AND TYPE OF COST

Millions of guilders

	LABOUR COST	OTHER CURRENT COST	CAPITAL EXPENDITURE	TOTAL
Business enterprises	.	.	.	.
Research institutes	48.4	12.2	1.0	61.6
Universities	52.0	8.0	18.0	78.0
TOTAL	100.4	20.2	19.0	139.6

For the business enterprise sector no data are available.

SOURCE: Netherlands Central Bureau of Statistics.

BOOK II

EXAMINERS' REPORT AND DISCUSSIONS

295-6

Part One

EXAMINERS' REPORT

THE EXAMINING TEAM

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INTRODUCTION

1. GENERAL

Most of the industrialised countries are spending a considerable amount of their GNP on R and D. This is believed to be one of the key elements responsible for their advanced position and economic strength. The Netherlands show an exceptionally high expenditure on R and D compared to other OECD countries and, in fact, the national figure of 2.2% almost equals France and the United Kingdom and is lower the United States (3.0%). This position is remarkable since no really "big science" projects are supported as is the case in countries with large defence R and D projects. This is demonstrated by the fact that, based on the statistics for 1966-1967, the figure for civilian R and D expenditure for the Netherlands (2.1%) is higher than that for the United States.

The basis for R and D work is scientific manpower and the Netherlands has built up a remarkable set of educational institutions which supply highly qualified scientific and technical personnel. There are many R and D institutions (both public and private) which appear to be well equipped although some of these are not used to their full potential.

There is at present a future challenge for the strong R and D community to contribute its work both to broad objectives and also to help define future objectives in line with national goals.

In all industrialised countries, as in the Netherlands, R and D policies are in a state of turmoil. Recently a marked change is noticeable in the way science and technology is developing. *

In spite of a tremendous increase in R and D over the last 20 years increasingly difficult problems arise. Society as a whole has lost confidence in the contributions that may come from successful R and D achievements. The "cry" to find a mechanism for assessing future technology is a typical sign of this changing attitude. R and D activities in their

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* Cf. Science, Growth and Society - A New Perspective, Report of the Committee chaired by Harvey Brooks, OECD, Paris, 1971.

present high volume are no longer isolated but have become part of a complex system. The Examiners therefore have analysed R and D activity as part of a total system. R and D activity either responds to specific needs or helps to define and achieve broader goals. It must be financed and its performance must be evaluated. It is therefore connected to the total system by different links, controlling this system, which may be called "feedback loops".

This report is essentially based on a ten day survey carried out by the Examiners in the Netherlands, during which they visited the following:

- Ministry of Education and Sciences;
- Ministry of Economic Affairs;
- Ministry of Agriculture and Fisheries;
- Ministry of Public Health and Environmental Health;
- Science Policy Council;
- Royal Netherlands Academy of Arts and Sciences;
- Organisation for Applied Scientific Research in the Netherlands TNO:
  a) Headquarters of the Organisation;
  b) Laboratories at Delft;
  c) National Defence Research Organisation TNO;
- Netherlands Organisation for the Advancement of Pure Research (ZWO);
- Netherlands Universities Council;
- Technical University, Delft;
- University of Nijmegen;
- Netherlands Agency for Aerospace Programmes (NIVR) and National Aerospace Laboratory (NLR);
- Reactor Centre, Netherlands (RCN);
- Delft Hydraulics Laboratory;
- Shell Research;
- Unilever Research;
- Fokker - VFW N.V.

During the above-mentioned visits or at discussion meetings organized for the Examiners at the Bureau of the Science Policy Council, the Examiners met representatives of the following:

- Ministry of Defence;
- Ministry of Social Affairs;
- Ministry of Culture, Recreation and Social Welfare;
- Ministry of Housing and Physical Planning - Agency for Physical Planning;
- a number of chairman of committees, set up by the Minister of Education and Sciences, advising on problems in the field of University Education, University Organisation, etc.;
- the Committee for a Preliminary Study of the Structure of Society ("Committee 2000") set up by the Minister of Education and Sciences.

Preceding these visits, the Examiners received the OECD report - "Reviews of National Science Policies - The Netherlands". As this report covers the entire R and D situation and the Examiners have only seen and discussed a part of it, their findings are complementary to this report and mainly analyse the information given during the visit rather than comment on the OECD report. The Examiners interpret their task as being an evaluation of the present Netherlands Science Policy. As they are experts in the field of R and D but objective outsiders to the Netherlands, they hope in this way to make a useful contribution to future decisions. As this report may be based on incomplete information, or data acquired during the visits may have been misinterpreted, the Examiners have chosen to identify areas where further investigations might be necessary and desirable rather than to formulate outright recommendations.

2. THE PRINCIPAL INTERACTIONS OF R AND D ACTIVITY

The Examiners' reflections are influenced by present day perception of interaction between R and D and society, an evolution which has become visible in all industrialised countries.

It would appear worthwhile to make the following general observations:

Historically, science activities were motivated by individuals, mainly due to curiosity and a desire to understand nature. It is only fairly recently that scientific research has become a tool for achieving specific goals on a large scale. Due to this evolution, scientific research is closely connected to development and technological innovation and has become an integral part of an increasingly intricate system. The evolution of a system with many variables is governed by different links or feedback loops, some of which are explicitly visible, others being only implicitly present. While scientific research in the early days could be considered as an open system (disconnected from society), today and in the future much of it will become a progressively closed system ("wired in" to society).

Research activities can be classified into the following categories:

i) Research as an expression of civilisation

As in the early days of scientific research, there remains today a continuous intellectual pressure to understand nature in order to progress deeper and deeper into the discovery and understanding of natural laws. It is an obvious necessity for such research to continue. This kind of scientific activity constitutes a rather open system as it is mainly governed by the interests of outstanding scientists. Due to the nature of an open system, there does not seem to be any yardstick for deciding what percentage of GNP is to be used for this purpose. A similar situation exists in the Arts. In view of the definition by Will Durant in his Encyclopedia on the History of Civilisation:

> "Civilisation is social order promoting total cultural creation. Four elements constitute it - economic provision, political organisation, moral traditions, pursuit of knowledge and the Arts. It begins where chaos and security end",

there appears to be a duty to contribute to the advance of civilisation by performing research.

ii) Scientific research for improving higher education

In order to teach, it is necessary to understand and therefore there is a close link between higher education and scientific research. This research activity is part of a different system in a sense, since its main purpose is not simply to gain knowledge but to provide for the advancement of scholarship and the training of new scientists or specialists. While these two purposes are easy to state, it has been difficult to establish definite guidelines for the assessment of performance, partly because of the long-range nature of the objectives and also because the different criteria needed to evaluate different fields and disciplines in a specific fashion are rudimentary at best and improvements tend to be resisted by the academic community in almost every country.

iii) Scientific research for achieving objectives

This activity represents a very closed system. The feedback loop here is evident - starting with a given objective, R and D results are achieved. Scientific knowledge already available and the additional knowledge gained also helps to define new and improved objectives. There

Figure 1

ILLUSTRATION OF R & D INTERACTION WITHIN THE NATION

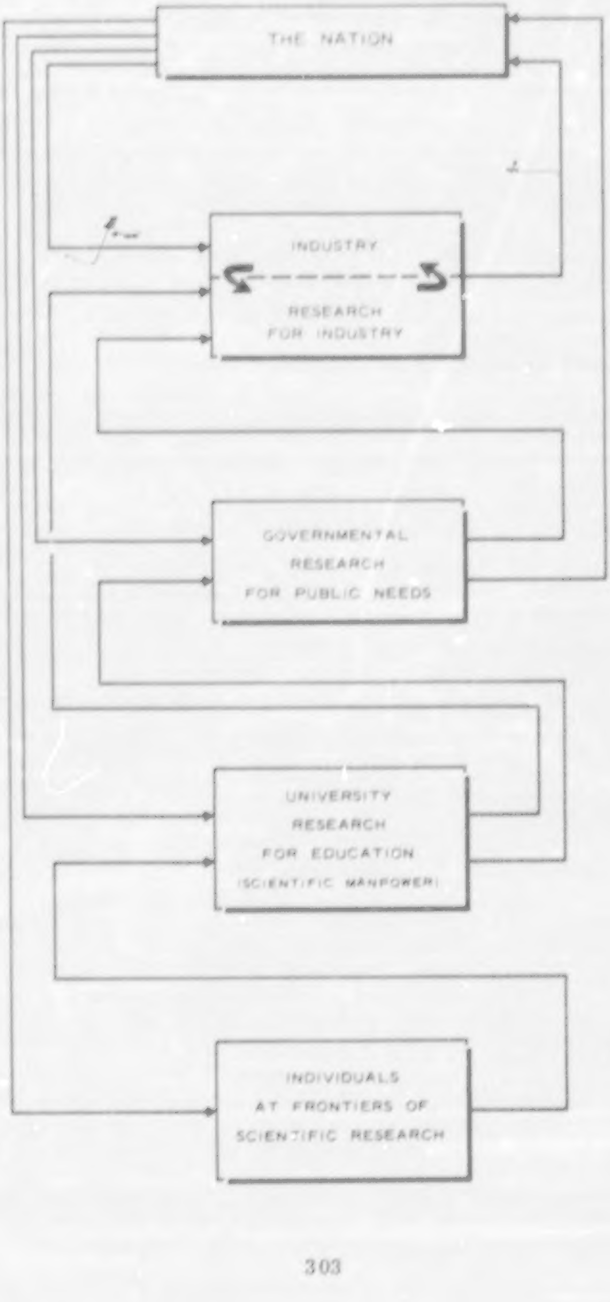
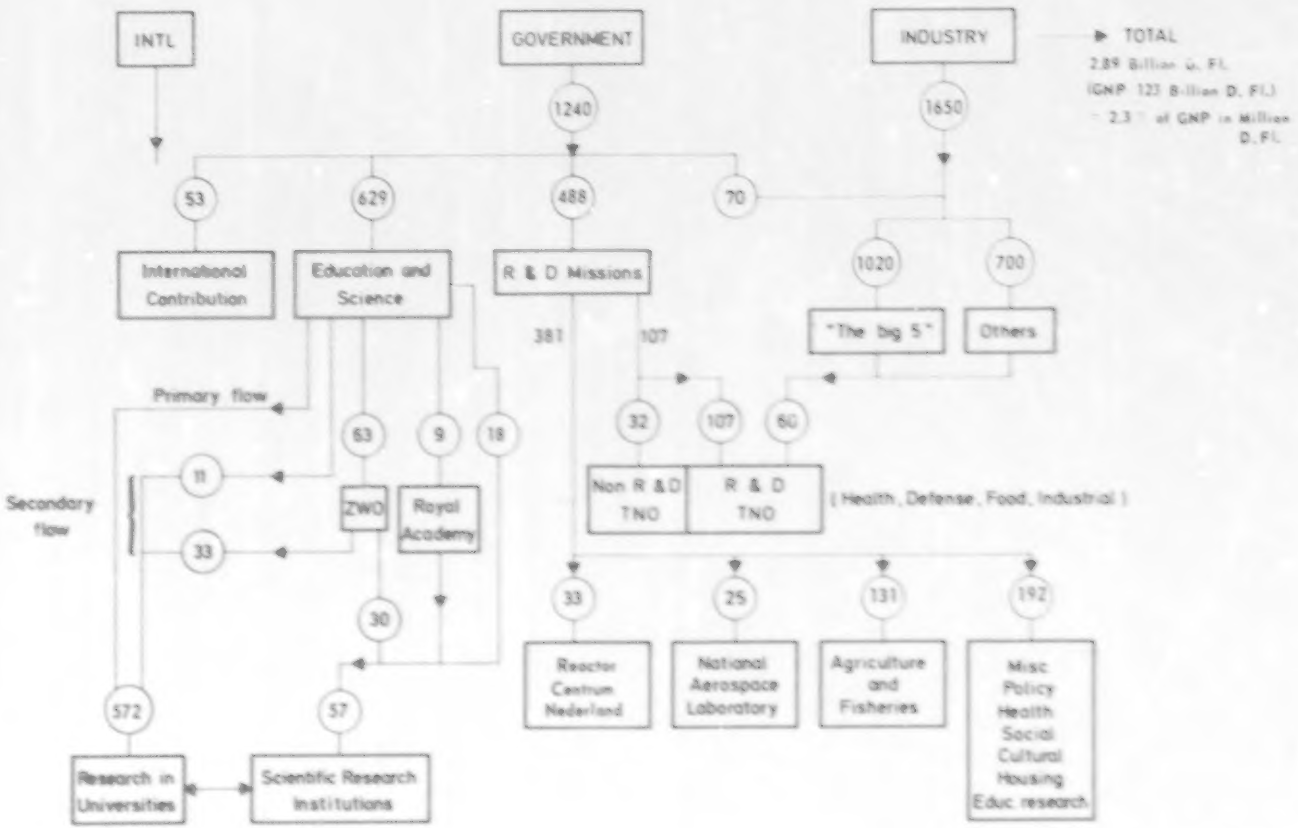

THE NATION
INDUSTRY
RESEARCH FOR INDUSTRY
GOVERNMENTAL RESEARCH FOR PUBLIC NEEDS
UNIVERSITY RESEARCH FOR EDUCATION (SCIENTIFIC MANPOWER)
INDIVIDUALS AT FRONTIERS OF SCIENTIFIC RESEARCH

Figure 2

MONEY FLOW - 1971


INTL
GOVERNMENT
INDUSTRY
TOTAL
2.89 Billion D. Fl.
(GNP 123 Billion D. Fl.)
~ 2.3 % of GNP in Million D. Fl.
1240
1650
53
629
488
70
International Contribution
Education and Science
R & D Missions
1020
700
"The big 5"
Others
381
107
Primary flow
32
107
60
63
9
18
11
Secondary flow
33
ZWO
Royal Academy
Non R & D TNO
R & D TNO
(Health, Defense, Food, Industrial)
30
33
25
131
192
572
57
Reactor Centrum Nederland
National Aerospace Laboratory
Agriculture and Fisheries
Misc
Policy
Health
Social
Cultural
Housing
Educ. research
Research in Universities
Scientific Research Institutions

has to be a source of funding for this activity and therefore an immediate beneficiary of it. In this way performance measures are rather easily applied. The objective can be of an industrial nature for nationalised or private companies, or it can be of national scope as defined by society, represented through the Governmental bodies. This latter sector of R and D is becoming more and more important. No factor does more to promote the efficiency of R and D than precise definition of objectives.

This investigation is guided by a central concept - R and D activities are connected with beneficiaries of R and D and funders of R and D by a complex system of feedback loops. In Figure 1, such a system is illustrated very schematically. The central part, called "nation", makes funds available to the R and D activity and also defines specific tasks. The "nation" is understood to be society as a whole with its different legislative and executive bodies. The four main recipients of these funds:

- industry, with its own research establishments;
- the Government research establishments;
- the University research institutions;
- the individual high-level scientists;

deliver an output flowing back to the nation through different feedback loops. The illustration points out that these feedback loops are more or less direct depending on the nature of the four recipients. In fact, R and D within industry represents a very tight link with the industry, the feedback in connection with Government research institutions is achieved by the response to the tasks allocated. Finally, the feedback for research carried out by the individual scientists is rather weak and occurs after considerable delay because the nation is not directly interested in research results but rather in the improvement of the level of scientists, mainly through its universities.

3. R AND D MONEY FLOW

In order to clarify the importance of R and D expenditure in the Netherlands, a summary of the major items is presented. The figures given are estimates for the year 1971 and do not take into consideration minor contributions. The diagram (Figure 2) represents the money flow as understood by the Examiners.

The "big five" illustrates the estimated R and D money spent by the five biggest industrial companies in the Netherlands, namely Shell, Unilever, Philips, AKZO, Dutch State Mines.

In the following chapters the performance of industrial R and D, with the largest money flow, is considered first, then university research and, finally, research for public needs.

I

INDUSTRIAL R AND D

1. THE KEY POINTS OF THE PRESENT SITUATION

- The Netherlands already benefits from a well established and renowned industrial R and D activity based on "the big five", on a number of medium sized companies and on specific research organisations.

- It is generally believed that R and D efforts are one of the key elements to industrial success.

- Industry receives funds for R and D programmes, to supplement its effort in specific industrial projects, directly from the Ministry of Transport, Public Works and Water Control. In this way it may become more competitive in international markets.

- There are well equipped R and D institutes which are not used to their full potential.

- The R and D departments in industry, as well as R and D organisations in general, appear to be satisfied with the quality of the university graduates they employ from Netherlands universities.

2. INDUSTRIAL R AND D

i) Its contribution to the nation

Many large outstanding companies have emerged in the Netherlands. These are considered as transnational corporations whose success is based on their entrepreneurial drive and solid R and D activity. Outside of the big five (Shell, Unilever. Philips, AKZO, Dutch State Mines) there are also exist numerous other industries with a considerable R and D activity which account for approximately 50% of the total R and D expenditure from private sources. The prosperity of the country depends to a large extent on the health of its industry. As the Government is continually preoccupied with economic performance and progress, it is increasingly supporting industrial R and D, both directly and indirectly. The support is estimated at 190 million Guilders for 1971. In contrast to some of the large countries such as the USA, UK, and France, the R and D funds are not used predominantly for so-called big science projects such as space and nuclear research or other lines motivated by national defence. The Netherlands research effort is much more diversified into many smaller efforts. This accounts for the complexity of the present situation and may also reflect a very high interest in R and D in the different sectors of industry and Government. As the total amount of money already appropriated for R and D is considerable in comparison with other countries, it seems unlikely that these funds will continue to increase at a high rate and the problem in the future may be primarily to allocate the funds more efficiently and effectively.

ii) The approach to industrial R and D

The prosperity and survival of industry depends on generating profits and on using them for new investments. Its R and D approach is therefore production- or system-oriented. Most of the R and D activity is subjected to rather strict control. New products and processes have to be produced continuously to assure a competitive position in the medium and long term. The long term research necessary to understand phenomena and to discover new industrial possibilities is important and perhaps less production- or system-oriented. It is performed in the laboratories of "the big five".

Of the total R and D expenditure by private industry, a very small amount is commissioned extramurally, to TNO for example.

A small amount of industrial R and D is related to so-called big science such as space, nuclear energy and, to a certain extent, to computers. Such efforts are not directly linked to an industrial product and serve to:

- introduce and maintain companies on a competitive international scale;
- keep alive a group of outstanding scientists;
- improve the ability to manage complex R and D projects.

To achieve the special character of such projects, financing is ensured by means of Government loans to industry. In the event of commercial success, the companies are required to repay the loan.

The issuing body is the Ministry of Economics but the receiver of such repayment and income is the Ministry of Finance, rather than a revolving or trust fund within the Economics Ministry. This procedure seems counter-productive since it makes it impossible for the programme to feed on its own success.

iii) Government R and D institutions relevant to industrial R and D TNO

- Its relevance to industry

In 1932, the Netherlands implemented a very interesting idea in building up the TNO Organisation which forms an excellent link concentrated on applied research.

The activity of TNO is rather broad and consists of research work of a long term nature as well as product and process development. TNO industrial research seeks to assist the Netherlands industries, in particular those which cannot maintain their own laboratories. Today, this part of TNO with a budget of 80 million Guilders is still highly subsidised by the Government and the work contracted from all kinds of industries amounts to only one quarter of the total budget. When considering the proportion of industrial contracts mentioned, it was observed that facilities with a total investment of the order of 200 million Guilders seem to be too large for use by only 1,300 people, roughly four times the yearly costs (40,000 Guilders times 1,300 people or 52 million Guilders). With only a few exceptions, international experience in laboratory operations generally shows a ratio between investment and yearly costs of the order of one to one which would indicate that at least four times more work could be carried out in the facilities available. Indeed, the visit to the TNO industrial laboratories gave the impression that, with the outstanding facilities available, more R and D work could be undertaken.

The question remains open whether this institutions is not too large in comparison to the extramural R and D needs of Dutch industry.

The Examiners observed that TNO's facilities are useful to the large companies. They already have laboratories of their own and research experience, and can realistically judge how much money and time is necessary to achieve results. Smaller companies have to gear their efforts to the short and medium terms and are, therefore, unable to embark upon R and D work of a long term, scientific character. They appreciate TNO's assistance when their staff and experience match the particular problem and a solution can be found with very little delay. However, it is unlike that such an institution would have "on its shelves" expertise that would cover the total industrial spectrum unless it were even larger and subsidised to an even greater extent. It might be worthwhile to study the possibility of creating an information centre instead of, or in addition to, extending the present laboratory facilities with a view to meeting the requirements of small and medium sized industries. Such an information centre should help to guide the industries to the competent R and D groups with the know-how necessary for immediate problem-solving not only in the Netherlands but in the whole world.

Another possibility to consider would be to orient the industrial section of TNO towards other national goals since the Government today is already paying the major part of the costs. Concentration on such projects may be advisable as it seems to be the only way of solving R and D problems which industry cannot meet or finance. Such national goals are already visible. The very dense population of the Netherlands and its growing industrial activity is creating problems in the field of optimal use of natural resources and environmental deterioration. A national laboratory such as TNO could be organised to carry out specific investigations. The achievement could then be measured and the performance of the laboratory evaluated. By this feedback loop the institution could develop in proportion as its proposals gain merit and its achievements win recognition. The results of specific investigations of the type suggested are likely to stimulate the creation of new products, new processes or new industries. This might create the basis for a new type of co-operation between Government and industry. It would become an attraction for young creative scientists interested in these problems closely related to the national interest. They could be transferred later to industry when their work proves to be relevant in terms of return on investment by industrial standards. The Examiners have seen an example within TNO's instrumentation sector which could already be the first step towards such an evolution.

- Its relevance to functional areas of national interest

The carrying out of a goal-oriented programme which meets the needs of the community requires a wide variety of skills. Such skills exist within the TNO institutions. In order to utilise these capabilities to their full extent however, the work must proceed under a co-ordinated specific plan. An example could be mentioned such as the establihment of a plan incorporating pollution research, research in soil mechanics, chemistry, bio-chemical research on pesticides together with work carried out within the Ministry of Agriculture and Fisheries. Consideration should be given to re-organising TNO as an executive institution for carrying out projects of a non discipline-oriented nature in order to achieve functions of national interest. The task of the recently created Scientific Council for Government Policy should be to define specific objectives for national interest. As this Council is attached to the Prime

Minister it represents the national interest above the particular problems of the ministries.

Other institutions

Representative of such institutions are the NLR, the Delft Hydraulics Laboratory and the Nederland Reactor Centrum. Institutions such as the National Aerospace Laboratory (NLR) undoubtedly perform outstanding work in aerodynamics. Its utilisation in the Netherlands, however, is extremely restricted because there is only one company producing aircraft. An analysis of this case shows that even if an industrial concern is of considerable size, its possibilities for using such laboratory and research assistance are sometimes surprisingly limited. Industry is mainly concerned with development work. The national industrial capacity to utilise the potential of the wind tunnel facility of NLR is far too limited. It seems that modern research facilities such as NLR of a size close to the minimum critical mass, are still too large for the industrial need of one small country.

Although such an industry as Fokker has a considerable number of employees, it cannot afford to undertake long term R and D projects. These projects are of a size that exceeds the limits of the industry concerned and the only possible solution seems the interaction and co-operation with companies outside the Netherlands, with all the complexities involved. The long term future of a facility such as NLR should be investigated in view of the increasing financial load in maintaining outstanding capabilities by means of public funds.

Another outstanding facility is the Delft Hydraulics Laboratory. It appears to undertake excellent work in a very specialised field with very up-to-date facilities. However, looking at the Netherlands' outstanding expertise in waterworks over the centuries, the question might be raised whether this R and D instrument could not be used more actively to create new industries for the future, rather than respond to specific tasks in the present reactive way. Such a laboratory could possibly be the initiative in creating new industrial opportunities, i. e. it could combine its knowledge of handling water with the knowhow of the Netherlands shipbuilding industry to produce innovations for offshore operations for petroleum and minerals, floating airports, etc.

A similar case is the NRC. A nuclear reactor facility, able to work in the forefront, needs considerable funding which is likely to increase with time. A particularly difficult situation exists as there is no single industrial company in the Netherlands of the size necessary to produce nuclear reactors; there are only some heavy industries who are interested in contributing to reactor systems with certain components. It might be investigated whether it is worthwhile developing research facilities further in order to justify the heavy yearly expenditure. The motivation for helping some industries interested in producing some of the components may not be sufficient. The Examiners have seen that most of the work is now linked to international projects; however the motivation for such collaboration is not clear - is it contributing to general knowledge or creating new industrial potential? Restating of goals might be advisable in view of the estimated increased budget for maintaining the existing organisation.

It seems that these three examples of national facilities reveal a difficult problem. How can a small industrialised country develop modern tools in R and D for sectors in which the critical mass exceeds the needs of the nation? The financial load may become prohibitive and, in addition, an unhealthy working climate may develop if no use is made of these facilities. International collaboration seems inevitable but with a plan for specialisation that assures that each country is not developing the same tools. How can a public financial effort, conceived for a national purpose, be justified within such an international setting ?

iv) The universities' contribution to industrial R and D

The Examiners observed that, in general, industrial laboratories are satisfied with the quality of the staff they select from universities.

It also became evident that it would be desirable to shorten university studies in order to transfer young people to the industries' research laboratories as soon as possible. Industry has only a secondary interest in the specific research and scientific knowledge gained at the universities. Its main requirement is for general scientific excellence of the students leaving the universities. The Examiners suggest consideration of this point in the formulation of recommendations for university education.

3. FURTHER INVESTIGATION OF THE FOLLOWING SEEMS WORTHWHILE

- The type of R and D projects which could be based on untapped and under-utilised resources within existing research facilities (exploratory approach);
- the type of R and D projects that are essential to attain national goals (product- and system-oriented research);
- ways and means of utilising R and D capabilities based on specific Netherlands experience (e.g. reclaiming of land) for new industrial activities on an international level;

- ways and means for small and medium companies to benefit from existing worldwide R and D activities (e.g. creation of a data bank);

- the future of specialised R and D institutions when maintenance of critical mass leads to a size which exceeds the national need.

II

RESEARCH IN THE UNIVERSITIES

1. THE KEY POINTS OF THE PRESENT SITUATION

Although the statistics available should be interpreted with caution, they nevertheless justify the following statements describing the present situation:

- Government expenditures in universities on R and D in natural sciences and engineering rose from 61 million Guilders in 1959 to 426 million Guilders in 1971, an increase of 7 times;

- Government expenditures in universities on R and D in social sciences (and humanities) rose from 10 million Guilders in 1959 to 102 million Guilders in 1971, an increase of 10 times;

- Research funds form about one-third of the total university budgets;

- A high proportion of total Government R and D funds are expended in the universities. (According to Figure 2 the universities accounted for about 50% of all Government supported R and D);

- A majority of university R and D expenditures are for fundamental and applied research rather than development (see Table 13 in the Background Report, p. 54);

- What does it cost the Government? In common with most governments of OECD Member countries, the Government of the Netherlands supports research and development in the nation's universities. A striking feature of the Netherlands science policy however is the very high proportion of the total Government R and D budget which is expended in these institutions. This proportion (as detailed in Table 64 of the Background Report, p. 241) is much higher than that in several other comparable European countries. Until now this expenditure by the Government on university and "Hogescholen" (technological universities) research has apparently been based solely upon the traditional view that university teaching and research should go hand-in-hand. The Examiners incidentally are in fundamental agreement with the thesis that research and the higher educational process are often inextricably intertwined, but it is clear that the enormous expansion of university education in the Netherlands in recent years is raising serious questions:

- can the future policy for support of university research be based on this traditional view alone (from a purely fiscal point of view) ?
- can the Government continue to allocate money for research, accepting almost complete autonomy of the recipient ?
- can the Government continue to pour money into a very decentralised system without indicating guidelines for apportioning funds among different fields or disciplines, without establishing co-ordination between the various universities and "Hogescholen" in planning the use of the funds and without a measure of performance ?
- should a distinction between funds for university research and those for general expenditure for higher education not be more explicit ?
- what does the public receive for this investment of its funds ?

The Examiners became aware that a key element in the evolution of the university system is the basic rule that each university professor should undertake research work. As teaching tasks are increasing, due to the rapidly growing enrolment, many additional staff members undertake research and the number of people involved in this field is growing. The total university staff already seems to be very high and the ratio of the number of students to the number of university employees is already low, reaching 3.5:1 with a further trend to more permanent employees. This evolution appears to be a direct consequence of the link between teaching and research. It seems desirable to review this situation and to develop a policy that will deal directly with the influence of research on university employment.

Although the results of much university research are published in appropriate scientific and scholarly journals and are mentioned generally in periodic reports of the institutions of higher learning, there are several drawbacks:

- there is no central mechanism for collection and compilation of information concerning the research projects supported, the results obtained or plans for future research;

- the Government of the Netherlands cannot now determine in any exact way what it is "buying" with nearly one-half of the tax funds expended for research and development;

- there does not exist any uniform set of mechanisms or procedures for ensuring:

  a) that the funds are spent efficiently;

  b) that areas of real scientific promise are supported;

  c) that funds are allocated on the basis of scientific merit and design of proposed projects;

  d) that some of the research undertaken will produce information which will ultimately contribute to national economic, social and educational goals.

To point out the lack of such mechanisms is not to imply that much, if not most, of the research in universities is not of high scientific quality or that much of the knowledge generated will not ultimately contribute to the solution of social and economic problems of national importance. For the present, however, the available information tends to be anecdotal, unco-ordinated and difficult to evaluate in many areas. There are notable exceptions in some of the disciplines such as physics and chemistry to which ZWO supplies support via the so-called "second flow" of research funds. Such extramural funds, however, constitute only about 10% of the support for university research.

2. THE APPROACH TO UNIVERSITY RESEARCH

For a professor to teach a subject out of books of the past without himself contributing actively and importantly to that subject is rightly regarded in the Netherlands as unacceptable. It is unfair to the students, it is unfair to the the country and it is unfair to the ideal of what a professor can be and should be. However, the claims of society perhaps deserve stronger statement than they receive today, both in what kind of research the professor does and in why the student gets a state-supported education.

As in many other countries, education in the Netherlands is considered primarily as a benefit to the individual rather than to society. Even in the support of mass education, the most often mentioned objective is social justice and equal opportunity rather than contribution to the society. For this reason, university R and D focuses almost exclusively upon exploration rather than development of products and systems. In the light of today's standards, this approach is only justified if an outstanding scientist or group of scientists is supported with unearmarked funds. What about the men who are not outstanding? Some measures of control might be necessary and some direction towards national goals.

The Examiners consider that although the Academic Council of the Universities is a body which could deal with this problem and is a useful forum for discussion of educational problems and policies, it is an advisory body only without executive power and:

- it does not offer a mechanism for realigning, co-ordinating and concentrating R and D within the universities;
- it must rely upon discussion and persuasion alone;
- it has no budgetary control and lacks any real power to enforce its recommendations to the Government or to the universities.

This does not imply in any way that the Examiners do not attach utmost importance to the concept that university budgets in the Netherlands (and elsewhere) should countain "free" or "unearmarked" money for research. Indeed, they hold that the availability of such funds is essential to maintaining scientific education of high quality.

Thinking of education in terms of social investment is rather recent but it is necessary in order to achieve a feed-back loop which today appears to be left to chance. It does, however, exist in an extremely elusive manner as, ultimately, education is always useful to any goal. Essentially this would mean introducing a normative justification for an increasing part of R and D projects which, in fact, has already been initiated by funding through the "second flow".

An alternative, which the Examiners believe is worthy of immediate exploration, would be to increase the funding through a body or organisation such as ZWO and thereby to use the "second flow" of research money to begin to co-ordinate and concentrate university research in the various scientific disciplines. ZWO appears to have earned the respect of Dutch academicians, and experience to date with such ZWO-funded foundations as SOM, FOM and FUNGO has shown clearly that co-ordination of scientific effort and the formulation of strong programmes of fundamental research is possible. The Examiners feel that if ZWO were enlarged to handle a much more important money flow, it might then be necessary to review its structure and procedures in order to avoid too strong a bureaucratic system. The ability to supply funds in substantial amounts is a key element in enabling an organisation to implement plans for co-ordination and concentration of R and D. In short, money supplies leverage. It is important that ZWO does not become too involved in continuously supporting research institutions instead of having a flexible approach through support of specific projects.

The Examiners are not in a position to suggest whether an increase in the "second flow" of funds via some ZWO-linked mechanism should be at the expense of the existing "first flow" or whether the potential benefits of co-ordination and concentration of university R and D might be great enough to justify supplemental funding via the "second flow" without diminishing the "first flow". The answer to this and other questions will involve policy decisions concerning the future rates of growth of governmental support for R and D, the effects of legislative changes recently adopted and now under consideration relating primarily to the educational functions of universities in the Netherlands, as well as other political, economic and social considerations. For what it is worth, however, it can be stated that the idea of using the "second-flow" of research funds via ZWO or some similar entity to hasten co-ordination and concentration of the R and D effort in the universities would appear recommendable to the Examiners.

3. THE NATIONAL POLICY ON HIGHER EDUCATION - ITS IMPLICATION FOR R AND D

The great dependence of the Government of the Netherlands upon the universities for the performance of R and D means, of course, that the relationship between the nation's policy for higher education and policy for science is an extremely close one. For this reason, it seems appropriate in this report to touch briefly upon the present state of higher education and plans for the future.

It would be repetitious to go over the recent history of the Netherlands universities in any great detail. Suffice it to say that the rapid and uneven expansion in numbers of students in recent can confidently be expected to continue unabated well into the 1960's if the existing, traditional system of open admissions for all post-secondary students who choose to attend a university remains unmodified.

From the point of view of the educational process, there is considerable evidence that quality is beginning to suffer appreciably because of unpredictable overcrowding and the necessity of utilising relatively inexperienced teaching personnel in many areas, notable examples being social sciences and civil engineering.

Similarly, the pressures of mass teaching are beginning to encroach seriously upon the time which the faculty can devote to scientific research. These pressures are unequally distributed among chairs, disciplines, faculties and universities since, in any given year, they are generated entirely by the students' free choice of institution and field of study. As a result of this unpredictability in planning at the institutional level from year to year and the unequal distribution of the load of entering students, some professorial units and faculties are under extreme pressure while others have yet to feel any major impact. Consequently, anecdotal information collected from various faculty members indicates a state of affairs ranging from serious disruption of research and scholarly investigation to "business as usual". It seems abundantly clear however, in the aggregate, that unless measures are instituted to lessen and to redistribute the educational load on the universities, the overall quality and effectiveness of university R and D in the Netherlands are bound to suffer a significant reduction within the next few years. Even among those disciplines that have not yet been deluged with students to the detriment of research, there is intense concern and great anxiety about what the immediate future will bring.

The political urgency of finding some solution to these problems arises mainly from:

- ever-increasing costs of supporting the present system of higher education;
- evidence of a surplus of university-educated specialists in such fields as veterinary medicine, chemistry, psychology and sociology.

This latter has complicated the issue and, inevitably, some co-ordination or at least rationalisation of educational policy and national manpower needs will be required. The Examiners got the impression that the surplus is mainly apparent in specialists with advanced degrees. However, there seems to be a lack of people with lower university degrees for less sophisticated jobs.

There is a widespread and keen awareness at all levels that the nation's universities are on the threshold of great difficulty as a result of ever-increasing enrolments. The visits of the Examiners coincided with a period of intense preoccupation with alternative future policies for higher education in the Netherlands. Indeed, in almost every interview, whether with Government officials, university administrators and faculty or industrial leaders, the Examiners were impressed that the future of the universities was a dominant theme.

Numerous councils and committees, both old and new, are seeking to devise and to recommend new policies and practices to correct the present unsatisfactory trends. Briefly, the following approaches have been proposed or are under consideration for reducing the student load by:

- selecting students at the end of the first year by examination;
- limiting the time allowed for completion of the first degree;
- institution of procedures to limit by selection the number of students who go on to work for doctoral degrees;
- attempts to divert post-secondary students from universities to vocational schools and colleges. This might mean incorporating these institutions and the universities into a single co-ordinated system allowing for "horizontal transfer" of students. It would certainly be dependent upon changing the well-entrenched and predominant view of the differential social, economic and occupational opportunities afforded by education in vocational schools and the universities.

4. EDUCATIONAL POLICY AND NATIONAL MANPOWER NEEDS

Almost no practical thought has been given to co-ordination of educational policy and national manpower needs although the eventual desirability of this is widely recognised. It might be necessary to specify the manpower needs according to the type of job, e.g. the Ph.D. level and the many other levels necessary for performing more practical jobs. It is also recognised, however, that long term projections or predictions of manpower needs are notoriously inaccurate the world over and that, until now, no nation, developed or developing, has successfully dealt with this problem. There has been little or no thought given to the international aspects of problems of higher education and manpower in terms of Common Market policy within Europe although, again, it is recognised that this dimension of the national problem in the Netherlands must eventually enter into planning for the future.

Finally, it can be stated that the problems of creating and implementing new policies for higher education in the Netherlands are urgent and are massively complex. The country is devoting intense effort to reforms but the shape of the future is by no means clear. The outcome, however, will be of crucial importance in the evolution of the science policy of a Government which, until now, has placed extraordinary reliance upon the universities for implementation of R and D effort.

5. SUGGESTIONS FOR DEEPER INVESTIGATION

It appears worthwhile further investigating:

- equality of universities versus specialisation through establishment of specialised programmes and centres of excellence;
- decentralisation (more autonomy of universities) to improve motivation for higher performance;
- mobility among universities for students and faculty;
- the implications of the tenure system in an effort to introduce mobility from outside the universities;
- increasing the importance of the "secondary flow" of R and D money through a system such as ZWO;
- improving the effectiveness of use of funds by some kind of research auditing:
  - are goals defined?
  - are R and D programmes established?
  - is someone checking that results are achieved?
- the national educational policy in relation to national manpower needs.

III

RESEARCH FOR PUBLIC NEEDS

1. THE KEY POINTS OF THE PRESENT SITUATION

- considerable R and D expenditure within the various sectors of the public function;
- the activity of the existing research centres seems to arise from their own initiative and not as a consequence of stated national goals;
- there already exist several scientific advisory councils which are intended to serve as bridges between government agencies and functional areas of national interest;
- R and D capabilities relevant to functional areas, such as Health and Environment, are presently incorporated in separate R and D facilities;
- some R and D institutions and "Stichtingen" appear to be below the critical mass.

2. ITS CONTRIBUTION TO THE NATION

As in nearly all countries, there now exists in the Netherlands a strong belief in the possibility that R and D efforts can be used to strengthen the development of a country in the various functional sectors of society and that this can be done from the R and D funding of approximately 600 million Guilders received through the various government departments. These funds serve national needs in areas such as agriculture and fisheries, social affairs and health or transport and waterworks.

3. THE APPROACH TO R AND D WITH A VIEW TO MEETING PUBLIC NEEDS

R and D efforts will become more effective if related to specific areas or sectors of common activity in the society. Examples of such areas might be defence, health or environmental control and protection. Priorities for specific R and D efforts in a given sector should depend on national goals and the degree of feasibility attached to individual projects. Decisive phases in the setting of these research priorities are therefore:

- explicit definition of national goals in each functional sector;
- formulation of a national R and D programme and related R and D projects;
- effective organisation for carrying out R and D projects by adequate institutes and laboratories.

This implies a strictly product- and system-oriented approach. R and D success is intimately related to the explicitness of national goals and their subdivisions. In order to meet public needs, R and D is essentially institutional, mission-oriented and non-academic.

The feedback loop as an inherent feature of mission-oriented R and D is obviously closed but it supposes that the R and D programmes are well established in accordance with the goals and that the responsible body is applying the results to the solution of problems and achievement of goals.

Areas of responsibility attached to the various ministries do not coincide with functional sectors of public interest. Environmental protection and health, for example, fall into the realm of at least three different ministries.

Co-ordination is essential between the ministries concerned in order to focus distinctly on functional areas of public activity. Scientific councils reporting to ministries are a means of co-ordination in many areas.

4. DISCUSSION OF R AND D IN SOME FUNCTIONAL AREAS

i) Defence

The defence programme might serve as a model to illustrate a clear sequencing of steps to formulate and implement R and D. Defence research and development projects are funded exclusively by the Ministry of Defence at an annual rate of approximately 50 million Guilders. The national goals underlying the programme formation are defined by the Netherlands Defence Research Co-ordination Committee, manned by representatives from the Ministries of Defence and Foreign Affairs. The execution of the projects is undertaken by the National Defence Research Organisation-TNO and also through special contracts with industry.

The research policy aims at keeping an adequate level of knowledge in technology and research ability in the country so as to enable the military forces to evaluate and utilise existing and newly developed weapons. No new big weapon systems are developed and this appears to be a balanced R and D programme in line with the country's needs.

ii) Health

R and D efforts which are of importance to the development of public health, including the medical system, are undertaken in the medical faculties of the universities, in the Institutes of the Royal Academy, in the Institutes supported by ZWO, through the Foundation of Fundamental Medical Research (FUNGO), the organisation for the Health Research-TNO and through the Ministry of Public Health and Environmental Hygiene. There are two advisory councils in this area, namely the Medical Scientific Research Council, sponsored by the Royal Academy, and the Council for Health Research, sponsored by TNO, and the question might be raised whether it would not be an advantage to restructure these two councils to create a single advisory body for health research. The present funding situation appears very complex with overlapping activities and it is therefore very difficult to estimate the research funds allocated to particular needs.

The Ministry of Public Health and Environmental Hygiene however is working very actively in its division of Public Health and in its Planning Section to compile more detailed information concerning the effort in all parts of this system. They also plan to extend research in preventive medicine and hygiene in their special division for Environmental Hygiene which will be mentioned later.

The co-ordination of the two scientific councils in the basic and applied area is essential to ensure an adequate scientific advisory inflow into the Ministry of Public Health and Environmental Hygiene, especially to its public health section. It appears that the planning section should work more actively with the scientific councils on priorities and proposals of research policy.

The institutional structure in the area of medical research and health investigations seems to be largely determined by historical circumstances and is insufficiently integrated. It appears worthwhile to investigate the possibility of centralising institutions and laboratories engaged in basic medical research. The ZWO and its Foundation of Fundamental Medical Research (FUNGO) could serve as the core of centralisation which would imply placing certain institutes of the Royal Academy and TNO under ZWO (FUNGO). This would improve co-ordination on the level of internal research programming and the inflow of advice concerning fundamental medical research. In an analogous way, one could investigate whether mission-oriented work in the field of health and prevention could not be centralised between Health Research-TNO and institutions set up by the Ministry of Public Health and Environmental Hygiene. National goals in this area could then be implemented under conditions conducive to high quality.

A review committee could be the advisory body formed by the restructuring of the two present councils. This would aim at the establishment of a coherent R and D programme and might serve as a means of channelling the increased funds available from the Ministry of Public Health and Environmental Hygiene in a co-ordinated manner.

iii) Agriculture

Agricultural research is carried out within the responsibility of the Ministry of Agriculture and Fisheries. The R and D effort has increased substantially, of the order of 10% per year. Three thousand people are employed in agricultural research. As the importance of agriculture, measured by the number of people employed, is decreasing, the fact of increased research effort seems astonishing. However, agriculture appears to have a good future in the Netherlands due to the special, favourable climatic conditions. As a result of R and D effort the productivity has been increased so that the Netherlands are exporting about 50% of their production. The research policies are continuously adapted to the changing conditions. Production orientated programmes are being enlarged to the total system of food, including marketing, process industries and packaging. A very great effort is also being undertaken towards industrialisation of agriculture. Increased attention is being given to the environmental conditions leading to improved application of pesticides, recycling problems and fertilisers.

There is a very positive attitude and conviction of the future of agriculture in the Netherlands and it has been demonstrated that agricultural research is becoming an activity as part of a total biological system.

iv) Environmental development and control

Environmental development and control is supported by:

Ministry	Area	Funds
Transport, Public Works and Water Control	Water management	9 million Guilders
Education and Science	Earth sciences, sea research and oceanography	10 million Guilders
Transport, Public Works and Water Control	Atmosphere and meteorology	3 million Guilders
Housing and Physical Planning	Physical planning	3 million Guilders
Agriculture and Fisheries	Physical environment	36 million Guilders
Public Health and Environmental Hygiene	Environmental hygiene	4 million Guilders
Culture, Recreation and Social Welfare	Protection of sites	2 million Guilders
TNO	Agriculture and health	6 million Guilders
	Total approximately:	73 million Guilders

It is difficult to estimate how much of the research funded is basic and how much is applied or truly directed towards developing environmental controls. A rough estimate would be that at least half the amount supports basic research.

The situation described above obviously calls for better co-ordination. A Cabinet's sub-council for the environment would appear to be a suitable body for defining national goals and devising mechanisms for co-ordination. A Council for Scientific Environmental Questions might operate usefully in advising the various ministries and the sub-council on the formation of R and D programmes. This set-up would probably enable the assessment of R and D best suited for their use. The transfer of certain R and D tasks from the Ministry of Agriculture and Fisheries into the TNO organisation is worth consideration for example. Any country, and especially one as densely populated as the Netherlands, will have to give increased attention to water and air pollution problems. Without cutting basic research, more emphasis should be given to practical R and D in mastering the environment.

vi) Social Development

Social sciences are supported by:

The universities (including humanities)	102 million Guilders
The Royal Academy - ZWO	3 million Guilders (1971)
Ministry of Social Affairs, Ministry of Culture, Recreation and Social Welfare	6 million Guilders*

The Royal Academy has established a Social Science Council to advise, stimulate and co-ordinate the development of social science research, especially in areas which have been neglected in the past.

The university chairs and faculties in social science are experiencing increasing difficulties in research because of student overloads.

ZWO has tried to encourage an expansion of research work in social sciences. The examiners discovered that, at the present time, there are more funds available than there are adequately qualified scientists and research proposals.

This situation might be met by more explicit goal setting by the following methods:

- formulation of national goals involving the ministries concerned with this functional area;
- funding to projects rather than to institutions;
- definition of R and D programmes and related programmes accordingly;
- establishment of a social science advisory council in order to advise the ministries on the use and enhancement of existing resources;
- integration of present institutions and "Stichtingen" with a view to closer co-operation with the universities and ZWO. This would result in an R and D organisation of a size adequate for achieving results;

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* To be consistent with the university R and D in social sciences (including humanities), the figures for governmental R and D should include also the Ministry of Education and Science as far as educational research (23 million Guilders) is concerned and the Ministry of Justice as regards crime and child protection (2 million Guilders).

- establishment and funding of research units in universities with a view to training and attracting scientists by involving them in a national programme.

5. SUGGESTIONS FOR DEEPER INVESTIGATIONS

It appears worthwhile to investigate:

- ways and means by which R and D can be used more specifically and therefore more directly, for well delineated, functional areas of national concern (e.g. health, environment, agriculture);
- the reason why social scientists have not responded to efforts to increase research, in particular research on the development of social policies, despite the importance the authorities attach to this area;
- the interface between advisory scientific bodies and the executive bodies of the Government with particular reference to the mechanism of inflow of scientific advice;
- feedback loops between sources of funds and results obtained from R and D work;
- whether R and D institutions and "Stichtingen" of limited size could be linked, by means of centralised funding and participation in joint projects, with a view to bringing them above the critical mass;
- the potential of capabilities and facilities available for work on R and D projects in relation to functional areas (and their subdivisions) of national interest.

IV

R AND D AND SCIENCE POLICY

1. THE KEY POINTS OF THE PRESENT SITUATION

- the urgent need to screen R and D expenditure led to the creation of the Science Policy Council of the Netherlands in 1966;
- this advisory body has suggested that the Government is not only a fund provider for R and D and that the results of R and D are important in defining and solving national goals;
- the complex situation of allocation of funds does not yet seem to have been greatly influenced by the Council's advice;
- the ministers or the Science Policy Council take initiatives for supporting specific research projects, in particular those of interdepartmental interest.

2. THE NEED FOR A SCIENCE POLICY

In all advanced countries it has become obvious that the science and R and D community can no longer rest on its own and pursue its work in isolation, and Science Policy has become an instrument for helping to overcome this gap. The Science Policy Council in the Netherlands was created in 1966. It has accomplished a considerable amount of work in the clarification of issues and has really come to grips with some of the basic problems.

It pointed out the dilemma that science flourishes when left unhindered but that this freedom can only be achieve in a solid system of reference and with a high degree of self-discipline. The responsibility lies not only with the scientist and research institutions, but also with the fund provider and it therefore became clear that the Government cannot restrict its role simply to that of a funding body. Indeed, at the present time, it is difficult to see how additional resources for R and D can be made available without interaction and involvement between scientists and the highest possible level of government.

All partners in R and D activity, the performers and the funders, are finally asking for defined science policies; however, it has been realised that this is an extremely complex problem. Due to this complexity, it can be questioned whether a solution, capable of implementation, is really feasible? The members of the R and D activity have all the characteristic difficulties common in complex human institutions. R and D increasingly becomes part of a total system, i.e. changes from the past open system to the present closed system. The Science Policy Council is helping to understand and guide the structuring of this closed system and may define different hierarchies within the system.

The Examiners found frustration within the Science Policy Council as the system for allocating funds has not been very greatly influenced by their advice. However, a unique system has been created which allows the Council to take more direct initiatives. Within the state budget an unearmarked fund has been provided and during the course of the year the ministers can decide for what specific purpose this fund is to be used. It is mainly allocated to research projects, of a maximum duration of three years, in which different departments are interested. Initiatives for such programmes can either be taken by the ministers themselves or suggested by the Science Policy Council, and the Examiners felt that this very flexible system could be encouraged further to become much more important (allocation according to the merit of the proposal, not according to sanctity of the institution).

Experience has shown that a science policy has to be tailored to national goal planning which, in itself, is a function of society's objectives and values. The question then arises - what form does the society of a country take and what is it aiming at for the future? National goal planning is therefore involved in the total concept of national decision making and, as such, interaction with the international scene as well.

In view of this situation, the Netherlands Government has taken the decision to set up a Scientific Council for Government Policy (SCGP) which is directly linked to the Prime Minister and an interdepartmental committee is working to define its tasks and its relation to the Science Policy Council. The Examiners would very much encourage the creation of a solid council as it is only on this level that national goals can be defined and implemented and they consider that the existence of this council may become the essential link for the total R and D system of the nation. It may become a tool for bringing the different ministers and departments together and pushing the decision-makers into defining their objectives. Many new problems facing further industrialisation, such as the deterioration of the environment, the problems of assessing consequences of new projects and the link to similar institutions in other countries, can only be handled on a high Government level. However, it is generally known that defining national goals is not the logical process of an analysis but is the result of different opinions and pressure groups. The effectiveness of the SCGP may depend to a large extent on the mastering of this political problem which is characteristic of the parliamentary democracy.

CONCLUDING REMARKS

R and D activity has been analysed in the three main branches - Industry, Government, Universities - and certain points have been raised which should be considered for its future development. Part of these remarks arise from the particular situation perceived by the Examiners and many touch problems related to R and D policies in all industrialised countries. Many of these remarks indicate that, for its own sake, R and D can no longer exist in its present large volume without better organisation and co-ordination. It can only survive as part of the total system which serves the needs and the goals of the nation. Many people in the Netherlands seem to be aware of these problems and there is a strong concern for improvement. Goal setting and the definition of programmes is very difficult and the problem of implementation is a very complex one that has not yet been solved and which falls into the decision-making domain of any social system linked to a democratic order.

Part Two

ACCOUNT OF THE CONFRONTATION MEETING

The Confrontation Meeting was held at the Technological University, Eindhoven, on 21st June, 1972, under the chairmanship of Sir R. Walker (Australia) and took place in the presence of the three Examiners and a special Netherlands Delegation consisting of:

Head of the Delegation:	Mr. M. L. de Brauw	Minister without portfolio for Science Policy and University Education.
Deputy head of the Delegation:	Prof. C.J.F. Böttcher	President, Science Policy Council of the Netherlands.
	*Mr. J. Kaufmann	Permanent Representative of the Netherlands at the OECD.
	*Mr. A.J. Piekaar	Director General for Sciences, Ministry of Education and Sciences.
	Mr. A.A.T. van Rhijn	Deputy Director General, Energy Supply, Ministry of Economic Affairs.
	Mr. A.J. van Oosten	Head of the Science Policy Section, Inspection of the Budget, Ministry of Finance.
	Mr. P. Siderius	Secretary General, Ministry of Public Health and Environmental Hygiene.

	Mr. G. de Bakker	Director, Agricultural Research, Ministry of Agriculture and Fisheries.
	*Mr. A.J.M. van Tienen	Head of the Division of Research and Planning, Ministry of Cultural Affairs, Recreation and Social Welfare.
	Prof. A.A.Th.M. van Trier	Chairman, Central Organisation for Applied Scientific Research TNO.
	Mr. J.H. Bannier	Vice-Chairman, Netherlands Organisation for Pure Research ZWO.
	Prof. P.J. Gaillard	Chairman, Division of Natural Sciences, Royal Netherlands Academy of Sciences and Letters.
	Prof. H.H. Janssen	Chairman, Council of the Netherlands Universities.
	Prof. H.G. van Bueren	Chairman, Scientific Council for Nuclear Energy.
	Prof. J. Kremers	In charge of preparing the creation of a Scientific Council for Government Policy.
	Prof. G.W. Rathenau	Director, Philips Research Laboratories.
Secretary:	Mr. C.H. Stefels	Head of the Science Policy Division, Ministry of Education and Sciences.

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* Mr. J. Kaufmann, Mr. A.J. Piekaar and Mr. A.J.M. van Tienen were unfortunately unable to attend the meeting.

Mr. Piekaar was represented by Mr. J. Nittel, counsellor for Sciences at the Ministry of Education and Sciences.

Mr. Kaufmann was represented by Mr. T.G. van der Tas, member of the Representation of the Netherlands at the OECD.

INTRODUCTION

The Chairman of the Meeting opened the discussion by stressing that the Member countries were particularly interested in the examination of the science policy of the Netherlands. This country was one of those who devote relatively the largest resources to science. It has been successful in creating a real symbiosis between education and economy as well as a rather balanced system of social development. These achievements and new problems they have raised were of great importance for all Member countries.

Speaking on behalf of the Netherlands Delegation, Mr. M. L. de Brauw, Minister without portfolio for Science Policy and University Education, extended cordial welcome to all members of the Committee for Science and Technology of the OECD, representatives of Member governments, Examiners, OECD Secretariat and the representatives of the Netherlands scientific, governmental and industrial circles. He expressed his gratitude to the Technological University of Eindhoven for having offered their hospitality for the Confrontation Meeting; this initiative enabled a large number of the Netherlands scientists and officials to be present and have an opportunity to attend the Meeting.

The examination of the Netherlands science policy has come at a very opportune moment. The first experimental phase of this policy lies now behind. Important innovations are being planned or introduced both in the field of research and higher education. The Government has adopted special measures for dealing with scientific matters.

There are new concepts of the role of science in society and in the operation of government which have to be translated in national terms. In dealing with these problems the Netherlands look forward to the advice of the OECD like in other occasions. The Netherlands Government always highly valued the co-operation in this Organisation, thanks to the composition of its membership, its active and forward-looking Secretariat and the expertise of its Science Directorate under the eminent leadership of Dr. King. The work in the field of science of the OECD will remain one of the main motors for the further development towards a dynamic internationally well-structured science policy of the western world.

The Examiners proved to be able to assimilate a great quantity of information andto obtain an overall pocture of the Netherlands situation and get an insight into a number of crucial problems within a very short limit of time. The Background Report with data compiled by the Secretariat in co-operation with national authorities is also a solid piece of work. The discussions of these documents will not fail to stimulate public opinion and will undoubtedly play an important role in the shaping of our science policy.

Mr. de Brauw started his preliminary remarks in quoting the Examiner's impression that in the Netherlands, in all sectors, relatively large sums are being spent on R and D. This does not mean, however, that the Dutch are so free in spending money; the opposite is rather the case. There are reasons for devoting important resources to the R and D effort.

Firstly, it should be pointed out that it is a national tradition of the Dutch to give a prominent place to science, with a slight preference perhaps for the natural sciences.

Then, there is the physical condition of the country. The neverending struggle with the sea led to a specialisation in hydraulic engineering. The geographical position favoured the development of trade, transport and international relations. Astronomy was developed as a tool for Dutch navigators. The Dutch have to study languages. They have also now centres for aeronautical and ship-building research. As a small and densely populated country without natural resources - with the exception of natural gas - they have to industrialise and concentrate on high quality products. Population density raises social problems and problems of physical planning and of the environment. Much reasearch has to be done in these fields. Much that comes under the heading "agricultural research" for instance is now concerned with subjects like landscape planning or social problems of rural communities.

An international comparison of the statistical data seems to confirm that the Netherlands are spending relatively much money on R and D in the universities. At the same time however university research in some sectors is in serious difficulties as a result of the pressure of ever-larger numbers of students. This seeming contradiction can be explained by the fact that since the last statistical inquiry conditions have changed. There is no clear picture of the present situation, which in itself deserves criticism. The amount of money that goes into research in the universities is certainly considerable; we do not believe that under the present conditions we get maximum results. There is an urgent need for new structures and procedures that will enable the Government to have a policy for this sector of research.

As to the industrial R and D, it is of course not by accident that five large international firms have concentrated to a considerable extent their research in the Netherlands. Such a thing is only possible if there is a favourable scientific climate and a sufficient supply of qualified scientific personnel. The presence of the large laboratories of these firms is certainly in many ways of importance to the Netherlands. It should not be forgotten however that these laboratories have a world-wide function and that as a consequence the Netherlands benefit only partly from the results obtained.

As regards facilities for the big science, the Examiners have raised the question of how a small industrialised country like the Netherlands can go on developing these modern tools for sectors in which the critical mass exceeds the needs of the nation. However, they have not fully taken into account the international function of these centers. Still, it is true that they do not pay their way on the basis of direct income from research contracts. But what is the alternative? Abandon everything that has been achieved so far and leave the field to bigger countries? The Netherlands are not ready to do so, though it is indeed necessary to make a deliberate choice. International co-operation would seem to present a solution.

The Chairman thanked the Minister for his opening statement that has already set certain problems within a framework valuable for further discussions. He introduced then formally the Examiners to the audience and invited Dr. Thiemann to present the Report of the Examiners to the Committee, in general terms before taking separately the specific topics on the agenda.

Dr. Thiemann stated that the Examiners could not pretend to be exhaustive or complete and that they hoped that their observations would throw some light on different aspects of the Netherlands science policy.

The discussion of the science policies follows in a very difficult phase of our evolution in practically all industrialised countries. We are all conscious that we are living in a transitional phase into a new period. Very many opinions have to be revised although they have been established solidly in the past. Due to the large amount of R and D effort and the large number of people involved, new problems are coming out. This is sometimes analysed as a transition from a scientific and technological push into the phase of a market pull. The feeling that science and technology as such is a worthwhile activity and should be pushed by all means is now yielding to the fact that this activity has to fulfil a purpose and that this can be expressed by market pull.

As to the general concept of the Examiners' Report, the Examiners felt that R and D as an activity is a part of a very complex system. The system means an interaction of many variables and a flow of inputs and outputs: we should endeavour to understand how it functions. There is an interaction of different parameters, one influencing the other. There are feedback loops which hold the system coherent. We should learn to understand the driving forces in this system. Is it safe-guarding of existing institutions ? Or is the driving force mainly on the side of specific research programmes.

A system has also hierarchies which allow it to be controlled. In R and D work there is a desire to detect and to define the higher hierarchies which may constitute a guidance for our understanding of this particular system.

RESEARCH IN THE UNIVERSITIES

Dr Bennett introduced then the topic "Research in the Universities."

The attention of the Examiners was drawn to the subject of research in the universities by a number of observations. Firstly, on a comparative basis, an unusually large proportion of Government expenditure for R and D goes directly or indirectly to the Dutch universities. Secondly - as is true in most systems of higher education in the western world - there has been a very rapid growth in the number of students in Dutch universities: because of the existing system, the impact of this growth of students has been felt rather unevenly in universities, in faculties and in various disciplines. The Examiners noted also that there were already signs that the universities may be producing an excess in certain fields but they were unable to discern any manpower policy that might be the basis for a new policy in terms of university education. They noted that in the structure of the Dutch Government science and higher education are linked - in contrast with the suggestion that has been made in other countries that science and technology might be linked in the structure of government - and that higher education might be left to itself. They presume that one of the reasons for this is the extraordinarily high expenditure of government research funds that occurs in universities.

The Examiners thought that it would be important to pose certain questions to those responsible for the Netherlands science policy.

The main justification of research funds in universities was based on the principle that research and higher education must be linked and that every professor should do research. This leads to the question whether or not there should not be some re-structuring or re-thinking of this hypothesis as the size of the university enterprise grows.

The Examiners raised the question as to whether there might be some benefit in establishing some sort of "auditing system", some co-ordination of the activities in the university through some possibly external agency to ensure that the expenditure of these funds was given the best opportunities in science and that the various disciplines were developed according to some predetermined priorities. Might not such a co-ordination be brought about by increasing the so-called second flow of funds through some external agency such as ZWO so that there could be some greater strategy for the development of research in the various disciplines?

Another question is whether it might not be better or advisable to define the objectives of university research in the perspective of producing results that will have application to the solution of problems which must be solved if national goals are to be achieved. The general impression was that there must be a sharper definition of the purposes for the expenditure of these funds in the university.

Still another problem is that of some new system for the selection of students, since the political, social and economic difficulties that arise from an over-production of scientists and engineers may be greater that those that arise from an under-production.

Finally, the Examiners raised the question as to what measures are envisaged that might enable the universities to better administer themselves and to better co-ordinate their activities, perhaps through some agreement to specialise in certain areas rather than to continue to operate semi-autonomously on the basis of their own policies.

In his reply Professor H.H. Janssem from the Netherlands Delegation pointed out that the relation between teaching and research constituted a very serious problem in the process of growth of Dutch universities. The university authorities feel that the answer to these question depends largely on whether they will succeed in maintaining a good balance between teaching and research in the universities. Generally speaking they think that the basic rule linking teaching with research should not be abandoned. This does not mean that things should remain as they were before. The linking of teaching and research cannot be any more the same for all students and all teachers.

There is a growing conviction that several levels of teaching will have to be established, in particular an under-graduate level and a graduate level - so that for the majority of students being formed at the under-graduate level the teaching element will be predominant, whereas for a restricted number of students at the graduate level the research element will be much more predominant than before. This would resemble more or less the Anglo-saxon system. Admission of students to the under-graduate level should be as free as possible but admission to the graduate level should be based upon a severe selection. It is necessary to create structures and mechanisms promoting the shifting of students from universities to other forms of higher education, e.g. professional schools and the other way round. A new legal structure is being presently worked out for this process.

On the teacher's level the possibility of doing research should be maintained as a criterion for the university system. However, this research will not be identical for all of them. We are trying to work out a distinction between "education-related research" and "specialised research". The latter will ask for more planning both on the local and national level, and in many cases for more concentration of financial means and personnel. For certain projects, it might ask for a different mode of allocation of funds, e.g. through the second flow of funds.

Professor B. Rexed considered that the organisational structure of the university that might help in differentiating the activities of teaching and research could be of the "department type". Inside a big department it is easy to differentiate the levels of activity of different people: some are more interested in teaching and those can take a big load of teaching; others are more interested in research and can do so more actively.

According to the new University Act of 1970, replied Professor H.H. Janssen, teaching and research units shall be created which will be of a structure very close to that of the department system. It should offer a much greater flexibility to teachers as to the choice of teaching or research duties.

Dr. Thiemann raised the question of the main goals of university research. It is admitted that fundamental contribution to scientific knowledge is done by a few outstanding people. What about the research work done by others ? On the part of industrial enterprise, there seems to be no particular desire in the Netherlands for having research results from the universities. Firms are interested in having good people, as young as possible, and not in research results. This notwithstanding, the expenditure on university R and D has risen, in the last ten years, ten times in social sciences and about five times in the natural sciences. This reflects the dynamics of the strong coupling between teaching and research: this involves that with the growing numbers of students and teachers, more people are involved in research who in their turn breed new people for research, etc. The question is how can such a dynamic process be controlled in the future?

In Professor Janssen's opinion one could say in a general sense that universities try to make research workers. Some of these research workers will become teachers in universities, some others will find a job in industry and services. The notion of university teacher should be seen in a larger context and we should not speak about teachers only but about research workers in general. Industry and public services expect from the universities to have people who are trained in scientific research and who can also be usefully employed in the national economy. One can say that universities do not help very much in solving research problems of industrial firms. Co-operation with industry is scarce. In technical universities there is a small amount of contract research. However, another important aspect of the university research is to guarantee a free margin of research, to do research that is not done elsewhere and to serve society in this broad sense.

Professor P.J. Gaillard, representative of the Royal Academy of Sciences made a plea for at least an intimate relationship between teaching and research even at the under-graduate level, because may be for a small number of students that is just the time in their lives that they can easily become inspired. Maybe the problems solved by some pieces of research are not of the utmost importance for the nation but they should be at least important for the problem's which were put before the young researchers. So getting results and solving some problems is just what we consider to create excellence. To initiate motivation one has to learn how to successfully explore new fields. One has to see how basic ideas generate. One has to see how new lines of research have to be pushed and it takes often many years before people are convinced that they are worthwhile pursuing. The main problem is thus to find ways to distinguish between those who are good for going into research and those who are not. This is clearly impossible when there are not many students. The attention of the decision-makers should therefore be concentrated on the point how can be stopped the overcrowding of the universities in order not to kill the real good university.

Research is inevitable, agreed Dr. King in his intervention, it is a must for the vitality of university teaching and for the inspiration of people. There is a basic problem however which is perhaps deeper, in relation to the function of the universities in the future in general. We are assuming that the university will continue to be what it has been in the past, an academic institution. This was certainly appropriate when, shall we say, 4% of the age group went to university, but now there is a tendency towards a mass university. And in a mass university in many countries we see in fact that with the average student the problem is not student activism but student apathy. The average student does not quite know why he is there. A proportion may be fired by the concept of new knowledge and by the excitement of research which is relected through the teacher's teaching, but for many this is a very remote thing. They are there for a ticket for a job and they do not even know which job. In such a situation is seems difficult to maintain that everyone who goes for higher education should be given an academic training. We must question the assumption that higher education is going on in its present academic form indefinitely and this in order to make sure that we can retain the research function for the sake of getting more knowledge which humanity badly needs for social and other purposes as well.

Reacting to these remarks, Minister de Brauw said that re-structuring of Dutch university education was under way. In the new set-up university studies will be looked at from two standpoints: a) the transition to mass education, b) the necessity of recurrent education. A proposal of law has been put before Parliament in which the first phase of higher education is structured on a four-year basis which is characterised by the fact that the studies will be executed on a full-time basis. Within this first stage, research plays a role: it is education-bound research where the relationship between staff and students and research is a very close one and can be quantified along the lines much similar to what is done now. The shortened study should not result in relegating research to a lower level. In the graduate phase however, highly qualified graduates will be enabled to spend another three years at most at the university with a research task which will take up about 60% of their time.

It will be possible to build in this whole concept of the re-structured higher education a planning system for the whole post-secondary education. We have made a rather traumatic experience in mis-judging the development of higher education with all the problems that emanate from it. It was decided to build up a system which will define the education and research staffs of the University, on a ten-year, a four-year and a one-year basis, every year, a system for which a university information system is being devised at the present time. As far as the education task is concerned quite a few instruments are already at hand which, it they are well inserted into the decision-making process will enable the Government to do some foothold work in planning in a relatively short period of time.

On the other hand, the problem is how to introduce the research element into the planning. Discussions are going on with a view to re-thinking the whole structure of research bodies and especially advisory ones within the research sphere. It is suggested to strengthen the role of the Science Policy Council and give it more foundation than it has now. By a re-alignment of several research organisations and advisory bodies, it should be possible to come to a better definition of national science policy which would be well related to national goals. Within such a framework, a ZWO type of organisation, probably more extended than it is now, will be functioning as the advisory body for the steering of the research at the universities.

It will, in close dialogue with the universities, identify areas that should have priorities. It will certainly help in deciding whether to concentrate such efforts at one or more universities and help in setting priorities in such a way that a more or less operational plan will emanate from it as soon as the results of the advisory communication can be introduced into the planning system. This should permit to define the education-bound research, the free policy area that should be left to universities as autonomous bodies, and the science projects which are more specialised and need larger funds. To this end, the ZWO approach would be strengthened with a second flow of funds. This will lead to a new pattern in allocation of funds.

Once the research projects are better identified, once a system of evaluation and of control is built, once budgetary control on research projects is established and there is a feedback duly functioning through the information system of the planning, the allocation of personnel places and staff at the universities might undergo a significant change with an accent on the education on the one side and a specific accent on research identified with specific groups of people not necessarily keeping up the link with teaching on the other side.

The Delegate for Canada was amazed at the similarity of the problems in various countries. The Examiners' Report states that the bulk of university research funding comes from the university budgets rather than from outside sources. The Examiners therefore suggest an increasing in funding from an outside source, perhaps through ZWO and in this way university research might be more directed towards national goals. Well, in Canada, the bulk of money comes from outside sources and we still have the complaint that it is not directed towards national goals. This seems to be largely so because the allocation is made on the basis of peer judgment and peers tend to propagate their own kind particularly in the field of basic research. If this is so is it suitable to choose an organisation such as ZWO to fund projects related to national goals.

Dr. Thiemann observed to this point that the problem is perhaps not the form but the basic system, not the funding in itself but the reasons which are behind the dynamics of its rapid increase. Why is a given human community demanding more and more? One possible explanation seems to be that if the average age of researchers tends to be constant it implies necessarily exponential growth and authorities will have to cope with it whether it is labeled direct or indirect funding.

Professor B. Rexed pointed out that there was nothing wrong with the mechanism of ZWO and other analogous bodies in other countries. The question is whether somebody indicates the direction to ZWO. There must be some mechanism in the country relating the programme forming bodies such as ZWO to higher goals.

The Delegate for Italy stressed the importance of the change in university structures as a consequence of the rapid growth of student numbers. The reform contemplated by the Dutch authorities is intended precisely to modify the structures concentrating on education at the first level and on research at a higher level of university training. When passing from an elite university to a mass university, the structure has to be reversed: in an elite university one goes from education to practical application, in a mass university one has to go from application to a higher level of education, in other words, to change completely the education of young people. This is not a problem of national goals but that of structural set-up and training mechanisms. It is why the experience of the Netherlands promises to be so interesting for all Member countries.

The Minister de Brauw agreed that the concept of the mass education university must be re-thought to include new problems and goals of society. It is of primary importance that research initiatives should always be allowed to come from the base, but such initiatives should have a very well-defined reference framework on a national scale. If we should succeed in defining better than we do now our national goals and the direction in which research should develop, we sould see that initiatives from the base will be more completely inspired by this national framework. At the same time, if we can identify better the decision-making process and if we can succeed in building the mechanism of evaluation, we shall come on the right road. A clear mechanism for our decision-making process will enable us to identify the means and the funds needed and to bring under control the process of growth which threatens now to come into conflict with many other priorities.

With respect to problems raised by ZWO and the selection of research projects, the Delegate for France quoted as an example the

French experience. In France research funds are distributed at three levels. The first one involves the funds given to university laboratories and which are entirely free; the amount of these funds is not very important but allows for free research to be supported in a minimal way. The second level is oriented by national scientific commissions mainly on the basis of scientific themes defined by scientists of good quality; in the framework of these themes, laboratories can apply for research funds. The amount of funds in this category is much more important than at the first level. This level is that of the CNRS in France and similar to what ZWO does in the Netherlands. The third level involves funds distributed by the Délégation générale à la Recherche Scientifique et Technique. This organism defines programmes which take into account both the scientific aspects and industrial interests. To apply for these funds laboratories must elaborate a programme which is in line with the general framework on a national level. The amount of funds distributed in this category is very important.

The system is not perfect and the main difficulties are : a) the lack of selectivity which is often due to the fact that important amounts of money have already been invested in programmes which prove of minor interest; b) some research work of industrial-scientific character gets rapidly outfashioned with respect to selected research themes. In the last analysis, the French system seems satisfactory as to the general concept and planning but presents still difficulties as to its efficient application.

The Delegate for Switzerland pointed out that constitutional laws in many countries give now a right to education for everybody and that the affluent society tends to ask just more education not necessarily linked with the preparation for professional activity. Education has another function in this context; ideally education should allow each individual to harmonise his achievement with the goals of society. Somewhat cynically it can be said that the affluent society wants to consume more luxury goods: higher education having been considered as a luxury good which is more and more accessible with the increasing income levels. If the university has a new function which is to prepare the individual for living within the society, large numbers of university teachers in some basic fields will be necessary. However, if the connection between research and teaching is maintained, research may tend to be concentrated in areas not particularly relevant for society as a whole. The connection between university research and university teaching has to be reconsidered with a view to concentrating teaching in some basic disciplines which would not be connected automatically with specialised research. It may not be possible to maintain always the connection between research and teaching.

The Delegate for the United Kingdom considered that the initiative taken by the Netherlands authorities moved in the direction of what is called in the United Kingdom a dual support system for research in the universities. Now, the United Kingdom is re-examining the structure for the Government support of research with a view to placing that research on a "customer/contractor basis" where it serves specific objectives of Government. This will have some effects on the sources of funding and will reach through to some part of research work which is done in the universities. But not by any means the whole of university research. Fundamental research will continue to get support within the higher education system, that is through the general grants which are given through the University Grants Committee. This must be substantially in the hands of peers. The United Kingdom therefore makes use of research councils for this purpose and notably in this area of the Science Research Council for making grants to universities for specific projects and for the support of post-graduate students engaged and being trained in research and for the providing of certain large facilities which are most economically provided centrally and in common use of the universities.

It is very difficult to determine how the university funds are precisely allocated. But a substantial part of the funding of research at universities comes through research council mechanisms which makes it possible to put support behind centres of excellence and to support certain particular priority areas. Something of the order of two fifths of the funding of university research in the United Kingdom is now being done on this basis and rather satisfactorily.

According to the Delegate for Yugoslavia one could conclude from the discussions that the basic problem lies in the definition of national goals. Were it possible to define national goals, it would be more or less a matter of technique to organise things in order to define tasks for realising these goals. In Yugoslavia, the financial support to university research is divided into two streams, the so-called education-related research and the other research; this latter is financed partly by a second flow of funds. Some problems appear rather different in smaller countries in comparison with bigger countries. For example, in a small country like Yugoslavia it is hardly possible to create sophisticated facilities in two places. The only way is to concentrate facilities and good people in the best place which is probably the university. It involves that related to bigger countries the higher education sector in smaller countries gets a higher percentage of Government money for research.

The Delegate for Germany remarked that defining national goals of today does not guarantee that these will be also national goals of tomorrow so that an area of liberty should be left to all sectors of research and not only to the university research.

The Minister de Brauw informed the audience that in the "science budget" of the Netherlands there was already a more or less 10 - 15% free area of non-allocated funds for new possibilities. Similar free area funds will be created within the new concept of university research.

As to the problem of research and national goals, OECD could be called upon to establish a communication between countries which are wrestling with the same problems so that each country might benefit from such exchange of views in building its own decision-making structures.

Mr. de Bakker added that as far the problem of high brow scientists was concerned the Dutch authorities recognise three main problems. Firstly that the number of jobs suitable for highly qualified scientists is limited and although they never worried about the "brain drain" they do not want to train scientists for export purposes. Secondly, both Government and industry need large numbers of high-brow scientists and this has to be taken into account by universities. Finally, the rapidly increasing number of students makes it both physically and financially impossible to give them all a long training of such a level that it would make them too highly qualified for relatively simpler jobs. Planned mechanisms by which the number of highbrow scientists will be kept within reasonable limits in the future imply that the majority of students will get a relatively short training, shorter than in the past, probably four years for most of the subjects. Moreover, the planned integration of all higher education, all post-secondary education is intended to open new avenues for adapting the distribution of students over universities on the one hand and professional schools on the other hand to the needs of the country. This shows that in practice there exist at least some general lines of an unwritten, but generally agreed on, manpower policy.

INDUSTRIAL R AND D

Dr. Thiemann introduced the topic of industrial R and D. In industry, research and development has to fill a specific task and to develop the backbone of the innovative process. Looking at the Netherlands situation, it is obvious that the private funding of industrial research is done for a large part by the big five companies. It may be deducted from it that there is no need for further interaction between industrial development and Government policies. However, the Examiners observed, as in other countries, that the future economic position of a country is related very closely to the success of industry which in its turn must have innovative power to wage international competition. Some outstanding research work is done, particularly in the Netherlands, in industrial laboratories. The question is whether there is a possibility of linking this work with future goals of society which may lead to new industries and new innovations which would not be possible otherwise.

In his answer, the Minister de Brauw expressed the opinion that in this field too there is a need for a systematic re-thinking of goals with respect to society's needs. In the governmental structure of the Netherlands there is a special Sub-Council of ministers comprising those ministries which are concerned with research in this field. The authorities are advised by bodies which oversee the whole of society and also by bodies that are more specially oriented towards specific sectors. The problem lies now in structuring this preparatory phase of decisions in such a way that there is a close link between those sectors and the whole. In this respect, the Dutch authorities continue to study the most suitable course that should be steered.

The Delegate for Switzerland pointed out that the problem of encouraging industrial R and D by the Government is very important especially in Switzerland. Whereas large companies can get along without any support from the Government, smaller and medium firms require some help. But it is difficult to decide the proper kind of help. In Switzerland there was a suggestion to organise a central data bank for smaller firms. A pilot study was made in the textile branch where are only smaller and medium sized firms. From the answers obtained one gets the impression that they do not require research at the present stage. They lack even the awareness of the results of research which is already existing. What they really need is personnel sufficiently aware of current scientific knowledge rather than support for specific research projects. The problem is how to advise small and medium sized firms to make them more research-conscious and, only as a second step, to help them to formulate research topics and hand out contracts with the support of the Government.

The Delegate for Italy asked for complementary information on development credits extended by the Ministry of Industry.

Mr. A. A. T. van Rhijn agreed entirely with the Delegate for Switzerland that in the medium and small sized industries the major problem is to make people aware of the necessity to be open for innovation. They are so busy with the daily problems and with enlarging their productive capacity and with marketing their products that they forget to take some time to examine what technological developments are in process and how they could be used in their specific productions. This has been one of the reasons that, for instance, in France, they moved the emphasis from the major big science projects towards the more traditional industries of medium and small size in order to give them help in the technological field.

As to the question of development credits raised by the Delegate for Italy, these credits are submitted to the Government and pass through two advisory institutions. First, there is an economic-technological institute which gives advice on the economic prospects and the technological merits of the proposals being made. This report is sent to an advisory council in which there are representatives of the Ministry together with three people who have a large experience in industry. As far as this selection is concerned emphasis is laid on experience in more technologically advanced industries rather than any other aspect. This seems to be the proper way of handling the proposals because those who apply are mostly medium,and small sized firms with concrete proposals which primarily need not scientific advice, but an experienced review of their plans.

The Delegate for Austria indicated that his country has a certain experience in the field of research in small and medium sized firms. A number of institutes for co-operative research have been created on a private basis. These institutes are partially supported by governmental funds and help smaller firms in R and D matters. What is the experience of the Netherlands in this field?

The Delegate for France pointed out that the French authorities created, some years ago, a special organisation for promotion of innovations - ANVAR - which means National Association for Valorisation of Research Work. Its main purpose is to put together university people and industry people to discuss the problems of diffusion and utilisation of research results. The difficulty is that the transfer of knowledge is not linear, in the sense of university-industry. Consequently, the main work of ANVAR is now to diffuse not only the scientific results but also to explain to both university and industrial people how to get better results. A central organisation is necessary, but it is not enough. The main thing is to create a permanent contact between one kind of people and the other.

An other interesting institution in France is the Fund "help to development". This fund is run by the Ministry of Industry and Scientific Research and its mechanism is quite simple. Government advances funds for development projects of small and medium sized firms. If the firm is successful, it pays back the money. One of the best examples of a development financed by this Fund is the little sport car industry Matra which is now quite well developed.

According to the Delegate for Sweden, the problem of a small country is that of small industry, as the large industry takes always care of its own research problems. What can be the role of universities? Are the universities prepared to accept to be advisors to small industry or to accept short term research contracts ? This is apparently against all academic tradition. In order to promote such co-operation, the Swedish Board of Technological Development has appointed at some of the universities a kind of liaison officer who is going to sell the research activities of the university to small entreprises in the region; this man can be called upon any time for advice and help.

This might be one approach to use more effectively research resources in a small country through a closer co-operation between universities and industry.

The Delegate for Belgium was interested in having some precisions as to the role of the Organisation TNO in helping small and medium sized industries and as to the degree of efficient utilisation of the facilities possessed by the Organisation.

Professor A.A. Th.M. van Trier agreed that the problem of linear planning and getting the full benefits from the results of research for industrial innovation is one of the main problems of the Organisation TNO and that this problem is the subject of continuous discussions. A special division has been set up to accompany the introduction of new results of research into industry. In this particular division, people are specialised with a view to transferring innovative knowledge to medium and small sized enterprises which have no R and D capacity of their own.

In general, in certain industrial branches TNO is serving industry well by making available the knowledge generated within or available in TNO, in other areas, there is certainly reason to try to improve the situation.

Referring to the question of the Belgian representative, Mr. van Trier contended the ratios of effectiveness calculated by the Examiners in their report. On the basis of the annual report 1971 for TNO as a whole the ratio between investments and yearly costs was about 1.4 : 1.

Dr. Thiemann pointed out that the small and middle sized firms looking for research help have some difficulties because when they are aware of a problem or a deficiency they want to have an immediate solution. They do not want an organisation drafting a research programme which may lead to a solution. In order to provide a research service for the small and middle sized firms with research tools, with as many keys to open all the locks which might be opened, is a tremendous effort. It can be doubted whether it is worthwhile to have such an arsenal of keys available in a small country just because small industries want to have solutions immediately. They should have a service in the form of a data bank in order to provide them with necessary contacts with skills and groups all over the world which may solve their particular problem.

Mr. van Rhijn commented further on the problem of help to industrial firms. Dutch industries are telling the Government they cannot progress fast enough to meet international competition without help to industrial R and D. However, they hardly accept the fact that such a help is necessarily limited by other needs.

There are many requests, both for assistance and directing the help. Selection is done by applying certain criteria. Some of these criteria can be mentioned: development of the market, competitive position, existing technological and scientific capability and above all managerial capacity. In some cases, help was given for technological projects involving also an enhancement of managerial capacities, e.g. in the case of the national astronomical satellite. This is done in the hope that after having participated in these national projects the industries concerned will be capable of joining in international ventures for larger projects being offered by international organisations.

Apart from that, having only the criteria just mentioned is not sufficient anymore, for a double reason. On the one hand, there are too many requests, on the other hand, the increase in the costs of R and D is such that we have to select, which is always a difficult problem. We are trying to relate the selection to surveys of future developments for various branches of industry that are being organised on a branch basis. The demand and other elements as the relative competition position are changing over time, very rapidly and this modifies future developments. Secondly, the views and opinions about what should be the desirable development are changing also rapidly - environmental problems, new views on the availability of energy, etc. - have changed radically some views we used to have. So there are many problems when one tries to present a picture of the desirable industrial structure for, say, 1980 or 1985. It is difficult to base government policy on such a picture because developments may change in the near future. This does not mean that we should not attempt to work out such a picture, but we should be careful in applying it directly to political measures. This shows the difficulty of having a solid base for selecting and giving priorities in industrial R and D.

As to the question whether research institutes should have a specific responsibility of translating their results into new industrial ventures, Mr. van Rhijn is rather doubtful about this approach. He wonders whether it is really possible for research institutions to find out what is really wanted by the market. In general, it is industry rather than research institutions who are capable of feeling what is requested by market forces and where the opportunities are. This is not to underestimate the positive results we have obtained in specific cases but on the whole it remains doubtful that such a philosophy could be used as a basis of policy. The Sappho report made by the University of Sussex gives a very clear indication that research and marketing should be kept as close together as possible. For that reason, in the last few years, emphasis was laid on research and development done by industries themselves rather than extending the activities within the already existing research laboratories.

In the last analysis, it is necessary to try again and again to develop a better view of future industrial developments, but not only developments in industry but also in society taken as a whole. The Dutch authorities have been trying to build up a kind of a think-tank that could help government institutions to orient the activities in the field of R and D. There is also a special foundation on the future technology; with the knowledge gathered in this foundation it may be possible to give a clearer direction to our R and D effort. On its part, the Council for Science Policy is also an instrument that could be of a great help in orienting our future R and D, also in the industrial field.

Professor G.W. Rathenau was astonished by the Examiners' statement that as the Dutch industries are spending the major part of the expenditure on R and D the Government has probably no need to help and direct them. What are the relations between the Government and industries? Two come to mind. The first is that the big industries offer a possibility of work to the population. The second is that the Government acts as a client that wants some products which the national industry can furnish. However, the existing industries change their product mix within a few years. They change it into new products and into more refined better products and they change also the production methods. Therefore to try to direct the country's R and D in these two ways seems very desirable. From the point of view of the industries, the contact with the Government seems very important because the industries want to know what are the national goals and Government institutions as well as universities can help to determine the desired proportions of products which the industries can furnish. The Government institutions can also, if certain national goals are established, give some support to universities and institutes of technology. So a co-operation can come into life as for example with the Dutch national network of the measurement of pollution where Government institutes, the Technological University of Eindhoven, the research laboratories of the Philips Company and Philips factories have co-operated together in a very good way.

As to national goals, industry tries to set its own goals. These goals are determined by an economic input but also by a social one and are naturally connected with the present capabilities and the past of the firm. Philips research laboratories created a group of people which includes a psychologist, an economist, technical people and the whole research organisation as a background, trying to work out an image of the world to come, in order to see how the company can serve the world and meet the needs of the society of tomorrow.

The transformation of research potential into quite new industrial ventures, which is considered as a possibility by the Examiners, seems a procedure with very little chance of success. Even within one firm, the research laboratory has always much difficulty to "sell" the results of research to product divisions. The best thing to do is to transfer not only the product from a research laboratory but also the man who has invented it to the product division. This may also be an interesting approach for Government institutions in regard to small and middle sized firms. It is very unlikely that a central databank would help to solve short range problems of small and medium sized industries. Experimental investigations show e.g. that for technical problem solution libraries and the like are much less helpful than past experience and personal contacts.

In Dr. Thiemann's opinion, it is too simplified to say that industry knows what to do. They need also a tremendous market organisation to find out what the need are. Visiting R and D institutions in the Netherlands the Examiners wondered whether these excellent instruments of R and D could be brought to other utilisations and form e.g. an integrated part of new ventures or new innovating industries. One can give as an example the knowledge and technological skill in hydraulics and waterworks which could lead to devising floating airports or in shipbuilding which could help to find new possibilities to drive ships with high power. This may lead to long-range kind of policies where Government laboratories may play a very important role. However, industry very seldom is in a position to make long-range plans but operates with medium range plans. It might be a good combination to bring the Government-owned research institutions to such an operative mode instead of waiting that somebody may need them.

This raises the question of internationalisation. As shows the example of the Netherlands, we have to think beyond the national boundaries. When looking to Europe as a whole we find the same kind of research facilities in many countries and also the same problems as to available resources in new fields of R and D. Thus appear duplication on the one hand and serious deficiencies on the other hand. New concepts are needed to bring these tools into an operational stage on the international level.

Dr. King pointed to the basic dichotomy between the big firms and the small ones which is particularly accentuated in the Netherlands. Neither the Examiners' nor the Background Report do bring out quite enough the interaction of the big firms on the rest of the economy. With their high degree of sophistication and knowledge of the world, these firms have an influence on the Netherlands scientific and technological manpower, appreciation of the world problems and adaptation to international markets. In the Netherlands, there is an understanding of the articulation between basic research, industrial research, development, production, marketing, which has been helped by the existence of the very large firms and which gives the Netherlands a certain amount of advantages.

With regard to the small firms, it is necessary to give them a good technological level. This may be done partly by the mystique of research, but it is mostly a problem of getting a level of technological awareness to enable them to assimilate information from different parts of the world and enable them to undertake innovations, many of which are merely incremental improvements to existing procedures.

While there is a great deal to be said for reinforcing the formal information awareness, the needs for the informal should no longer be underestimated. If you look carefully in the Sappho report, it was not marketing research in the normal way that mattered, but market education. The really innovative firm will not merely submit to the market forces, it will change the market forces by educating the user, which may be other firms as to the significance and possibilities of new ideas. It is this kind of innovative feeling in industry of which research and innovation in the old engineering sense are in fact only symptoms and by-products but not the real motivating force. The real motivation force is a kind of new entrepreneurship where the entrepreneurial spirit is reinforced by knowledge of the real situation which is no longer intuitive but is intuitive plus rational.

With regard to the big firms in the Netherlands and other countries, we are reaching a stage in the sophistication size and expense of development that even the individual large firms can hardly any longer undertake the total development needs and costs of the next generation of technologies, such as nuclear, etc. For example very recently in Japan, big industry has come to the Ministry of International Trade and indicated that they can no longer be responsible for the big innovations in the future and that now the Government will have to enter into a strategical alliance with industry to identify the needs that are linked to the industrial national goals which are related to both the economic and social goals of Japanese society, and to develop a new approach through contracts and other means.

For the Netherlands their own market is not big enough to be other than a kind of pilot plant for the world market. But as part of Europe, the Netherlands firms have enormous possibilities which cannot be fully implemented unless a combined industrial/government strategy is created which is connected with national goals but goes far beyond.

Articulating science policy only with the social and economic policies today is self-defeating. It would relegate science to trouble-shooting and not much more. Science policy is not yet proven, it is still a groping subject. How can we clutch on to the social and economic problems ten years hence ? That is the basic problem of science policy. So science policy and industrial policy, and particularly industrial technical policy must be prospective. We will never succeed 100% in this but we can succeed a great deal more that we do at present. But the classical parliamentary cycle in our democracies of the four to five years elections with the concentration in meeting the problems as understood by the population today, inhibits us aginst going into these longer term problems.

Professor B. Rexed recalled his earlier capacity as Adviser to the Swedish Government and made a comment on the experience of his country. The big firms, he said, have their own means, their own possibilities of development and live their own lives to a certain extent. What they feel important is a good economic situation, a good taxation policy, a good investment policy. However, the problem of help arises in the case of small or middle sized industries. In any country, this kind of industry is still a very important one and gives employment opportunities to a large part of the population. The Examiners could feel in the Netherlands that these firms had needs which they did not think were quite filled, even though TNO certainly makes a great contribution in helping them in various ways. This is an unsolved problem in all countries.

RESEARCH IN GOVERNMENT INSTITUTIONS

Professor B. Rexed introduced the topic "Research in Government institutions".

The area of Government institutions is really the area of Government responsibilities in research as to such needs in the society which we might call collective needs. We approach here an area where the ordinary market mechanisms do not operate any more. In industry we can work and make theories inside the model of the world where the needs are translated in a kind of consumer's feedback as a pressure on the production and on the research and scientific effort and this forms a loop that operates functionally all the time. In approaching such functional sectors in the society as defense, health, environmental protection, the organisation of social welfare systems, we approach areas where there is no market mechanism in operation. There are great needs in the society but the needs will have to be filled through other kinds of development efforts than through a feedback loop of market mechanisms.

Therefore, we have to work with some kind of politically decided ambitions, be they called citizens wishes, or social ambitions or national goals. In some way, ideas about the future will have to be formed. Starting with these ideas we will have to move through planning forward in a definite direction. The question is how can we devise scientific and research effort to help us in travelling along the road forwards.

Certain clearly described stages have to be defined. The first is to be able to define explicitly national goals inside a given functional sector and by functional sector is meant defense, health, social welfare, etc. We have to try to find a mechanism whereby we could define our ambitions, give them more concreteness and really form national goals. The second stage is to formulate R and D programmes that would encompass the efforts necessary in research to help us achieve the goals.

Such programmes would be planning programmes. In many areas, where we do not know enough to achieve the goals, we would have to formulate research projects to fill in the knowledge that is missing. We will need institutions that can perform this task and make these projects come into reality. It would have to be a double planning system. On the one hand there must be a planning organisation which operates from the highest by the Government-taken decisions down to the practical field of experiments to implement reforms which have already been made but where there are small missing links to make it possible to have reforms operational. This means a rationally organised system of efforts from Government and planning institutions down to the effective implementation in a co-ordinated institutional structure. The most difficult problem is how to get the feedback when decisions and reforms do not operate just the way you want.

If we look now at the Dutch system from this point of view, the Examiners found that the defense area is probably almost ideal in the Netherlands in connection with such a system. Within a limited ambition, it is clearly defining and reorganising its goals all the time and it has an institutional organisation that is capable of fulfilling the needs of this sector. There is a good example of rationally set goals which are quite easily set in defense because the nation decides in a way its future.

In health, a clear definition is needed of goals and advisory bodies. We see in the middle field of programme and project forming two organisations, ZWO and TNO, and we notice that they are perhaps not so clearly directed as one would wish in the ideal system. We think that perhaps one could try to organise programme and project formation better if clearer national goals were defined.

If one moves to other areas, other problems appear. In the area of social development for instance, we notice that the basic research in the universities probably has much greater resources than the applied area and probably one should try to develop the lesser one by analysing the situation in somewhat the same way as for health.

In the area of social research, the Examiners thought that the institutions were rather small and probably not attaining the critical mass that is needed for an institution to be able to work with good scientific effect. Perhaps one should not only strengthen this field of implementation in comparison to the existing situation, but also reorganise it to make the institutions more vital and more up to the ambitions that they will have to fulfil.

The environmental development and control with a large investment already there is the problem of co-ordination more important than anything else.

The general procedure can be summed up as follows: formulate society's ambitions clearly and then devise programmes and projects rationally against these ambitions and national goals and see to it that the implementation field is rationally and effectively organised.

In his answer, the Minister de Brauw expressed the hope that within five years from now the educational and scientific planning in the Netherlands will be operational. This is in a certain sense a closed system which can be relatively easily organised. However, we are confronted at once with connections outside that system. To cite one example, that of medical faculties, their function in the academic hospital, the function of the academic hospital in the health system as a whole. There is an interface between the health sector and the educational sector and the need arises to elaborate the planning system is such a way that it can integrally approach this interface. It necessitates the building up of the same sort of planning in the health sphere as in the educational one and in the scientific field in the narrow sense. Going still further, we come to the national level to which is addressed the suggestion of the Examiners that it is on that level that national goals should be formulated. This is of course easily said and not easily executed.

We consider restructuring the Science Policy Committee to enable it to overlook the whole area of R and D, the industrial world, the social organisations and to elaborate desirable policies for different disciplines. Within such specific frameworks, planning should be taken up on a second level where it seems possible to come to a certain amount of concentration which will - as far as universities are concerned certainly - need an integration of strategic and tactical science. It will probably demonstrate the necessity of keeping alive organisations with a very specific character but in a context of a better co-ordination.

Professor C.J.F. Böttcher made a comment on setting up of national goals. The better the analysis of long-term goals is, the less suitable it is for policy making. As far as national goals are concerned this is because the public is generally not interested in long-term goals but in short-term measures. Very often, in view of relevant long-term goals one needs to take unpopular short-term measures and that is the great difficulty for politicians. We have not found a good solution for the problem yet. Another difficulty in setting goals for government institutions is that these goals are changing and continuously under consideration.

Mr. G. de Bakker of the Netherlands Delegation commented then on R and D in agriculture. Agricultural research is organised in an unusual way: there is not much research done by private industry except for the few commodities that are important for use in industry, and on the other side of the marketing channel one finds some industrial research done for the transformation of agricultural commodities and for food technology. Most of the research is done in governmental research institutions and in agricultural faculties of the universities. For this type of R and D questions like "what are the national goals" or "in what way can the results be transmitted to the users" do not matter very much, because in most countries, there is a very extensive system for the transmittal of the results to farmers and other users.

The problem is more of shaping programmes in the universities and in applied research institutes in a way that they do not overlap, that there is sufficient co-operation and that the more expensive facilities are used to the best of our knowledge. In the Netherlands, most of R and D in agriculture is concentrated in one town, Wageningen, around the agricultural university, which facilitates the co-operation. A second good thing is that most of the institutes came into existance by initiatives of professors of the university so that there is a good natural co-operation between the institutes and the relevant professor or department in the university. A third good thing is that in the Organisation TNO a council for agricultural research has been set up with the purpose of establishing contact between research workers in the universities, in institutes and in industry. A number of quite important working parties are set up which permit a fruitful dialogue. It is hoped that still a more co-ordinated approach will be made in the future when various reforms will come into existence.

Mr. P. Siderius talked then about the field of public health and environmental hygiene. There are several medical faculties and many institutions operating in this field including Government institutes. The matter of co-ordination is quite complicated in this field.

In representing the Ministry of Health and Environmental Hygiene, the functional sector concerned is public health and environmental control. Part of the work in relation to these missions is performed in Government institutions but a considerable part also outside. Therefore, the activities of our departments have been, and will be also in the future, directed towards co-ordinating and stimulating R and D activities of the various institutions in and outside the Government as far as such activities may be useful to reach specific national goals in the broad field of health. There are in this area different patterns of co-operation in use and depending on goals to be set.

Co-operation between Government institutions and industry could be easily extended. As an example, one may cite the development of pollution control systems. Under the co-ordinating activity of the Ministry of Health and Environmental Hygiene an automated air pollution control system and a water quality control system have been developed in collaboration between Government institutions, in this specific case the National Institute of Health, and industry. The second example may be the development of a hospital information system also in co-operation between certain hospitals and industry. A third example is the development of a food supply system in hospitals taking into account the cost as well as specific dietary demands in hospitals.

As to the Examiners' suggestion with regard to the advisory inflow leading to a co-operation between Government agencies TNO and ZWO and industry, as well as the universities, it can be said that already in 1970 the Ministry of Health took the initiative to set up the Health Council TNO. At the same time the Medical Research Council was set up by the Academy of Sciences. A combination of the two bodies is under study and may finally lead to a national review and advisory council on health research, as suggested by the Examiners.

Professor A. A. Th. M. van Trier concentrated on two remarks. Inside the central organisation TNO for the past few years a number of various advisory Councils came gradually into existence, with the purpose to help the Government to identify national goals. In principle, the composition of these councils is the same: Government, scientists and representatives of customers or potential users of new knowledge. However, only one part of the problem will be solved when these councils will have formulated co-ordinated programmes on the national level. The difficulty remains how to transfer the results generated in research institutions to implementation stages.

The Delegate for Sweden commented further on the problem of national goals. As to the idea of Government institutions setting general goals and linking them down to the scientific world, it raises the question how these institutions will be made competent to deal with new scientific information and how they will be able to order it for implementation. This kind of competence must be built in. And when ordering such competences, we come back to the crux of the whole matter: science, research and technology has been dealt with as a kind of package. It is the package which counts. But that package can be of a different quality. What type of quality criteria do we put on the package. Obviously, in the scientific community, it is an internal scientific criterion which can be raised very high, especially if there are only few scientists in the field. That is one extreme. On the other hand, if external criteria are applied which the public bodies want to apply, it may happen that a high level of external criteria is met by a low scientific competence level.

The Delegate for the United Kingdom pointed out that the research in Government institutions in his country has been given considerable thought over the last years. The basic proposition is that this research should be done on a customer/contractor basis. The extent to which this should be done is of course the matter to which a good deal of anxious thought is still being given. The problem is that one talks of national problems and national policy for R and D per se, but it must always be seen as ancillary to the objectives of the Government in a particular functional area. It is rather an aspect of the functional objective of one part of the Government and, of course, the Government joins all its objectives in a national programme at a central political level.

The Delegate for Italy asked for more information concerning the role of ZWO and TNO in the advisory and decision-making process.

The Minister de Brauw summed up the principles of the system of evaluation the Dutch authorities intend to introduce in universities. The university world has the know-how that is needed to judge planning processes. We should look there for knowledgeable people that are willing to assist us in the planning process in an advisory capacity. Independent committees can then be created to elaborate planning proposals in a dialogue with the universities. These committees produce reports in which their advice is laid down. These reports are published and judged by top university organisation and by Government.

If Government deviates from the advice in any respect this is also a published decision where alternatives which have been rejected and others that have been accepted are necessarily motivated. So again a dialogue can be continued through which we can come to the best possible solution whereby the advisory body acts as a bridge between the university world and the Government. We are thinking of letting the Government executives attend those meetings so that we can assure that planning advice will be constructive within the national framework. Not only the national framework from the point of view of scientific development but also the financial and economic national framework. We have no need for idealistic advice which is not applicable.

Mr. J.H. Bannier commented on the role of ZWO in the advisory and decision-making process. Formulating policy is something different from planning. At ZWO the knowledge which is coming up from the scientists in the country through the system of peers at different levels is channelled as an input in the formulation of science policy. It is rather a way of dealing with research policy and not so much with science policy. The part played by ZWO in science policy is mainly to help in but not to formulate it.

GOVERNMENT INSTITUTIONS FOR SCIENCE POLICY

Dr. Thiemann introduced the topic "Government Institutions for Science Policy". All previous topics and discussions have been leading to this basic topic. The problem of institutions is one of the most difficult ones, as it concerns not only the institutional set-up itself but also the instruments by which the Government can define national goals and the means which permit to implement appropriate decisions. It is of particular interest to see that the Dutch Government is taking an initiative of creating a body on sufficiently high level to be able to build up the necessary functioning structure.

The Minister de Brauw pointed out that during the last few years, the conviction has been growing that government policy should be initiated from a much more integrated point of view than the traditional sectoral approach. There is now already a special Ministerial Sub-Council for Science Policy. There are quite a number of other Ministerial Sub-Councils for different areas of governmental care where this inter-departmental approach is being initiated. An important further step is the decision to create the Scientific Council for Government Policy. This Council is intended as an independent advisory body to the Government, responsible to the Prime Minister. Its task is to provide insight into the future development of society and thereby signal bottlenecks in long-term development, identify problem areas with regard to Government policies and suggest alternative policies. It is not a body for policy formulation. It provides the Government with a long-term framework that enables the latter to set priorities and execute a consistent short-term and medium-term policy, relevant also in the long-term. The Council has the benefits of the results of research done in various institutions. We are very keen on mobilising operationalised results of research in such a way that we can benefit from it optimally in choosing our long term goals. For this reason one of the fixed members of this Council will be a member of the Science Policy Council, so that there is a very close inter-relationship between the two Councils. Should, for example, the Scientific Council for Government Policy indicate that a certain area is not covered sufficiently or has not generated sufficient research results, it will be directly communicated to the Science Policy Council which will advise the Government on how to fill in the blanks. With regard to activities in the field of planning of the future, the Scientific Council for Government Policy will advise the Government on the elimination of structural short-comings and on stimulation of research in particular areas. It will advise it also on the improvement of communication and co-ordination.

Professor J. Kremers elaborated further on the creation of the Scientific Council for Government Policy. The task of this Council is an extremely complicated and difficult one. The Dutch Government took the decision that the Council will take due account of results of research done by other bodies. This means that there will be a very strong working relationship with other bodies in this field. What is meant by these other bodies? On the one side, all kinds of creative persons and institutions in our society, especially the universities and industry. On the other side, our ministries and our central institutions. It is important to bear in mind that there is a number of very good planning institutes in the Netherlands, especially the Central Planning Bureau, the Central Bureau for Physical Planning, the Central Office for Statistics, the Science Policy Council and perhaps in the future the Advisory Body or Planning Bureau for Social and Cultural Welfare.

One of the first steps that the new Council must take is to try to co-ordinate, integrate and perhaps stimulate the work that is done by those institutes. There is a lot of planning going on in the Netherlands. The main problem is the need for a better co-ordination and integration in a long term perspective.

The Delegate for Belgium asked what would be the composition of the Scientific Council for Government Policy.

We are thinking of five full-time members and a few part-time members at the beginning - answered the Minister de Brauw. These persons should have a very good understanding of the scientific field but have above all experience, steering experience, in different areas of society.

Professor C.J.F. Böttcher pointed out that integral planning is closely related to the R and D function, mainly to a considerable portion of its applied R and D components because such research activities are directed towards the future of society. Dr. King rightly said that science policy must be perspective. In other words, one of the pillars of long-term planning must be technological forecasting based on knowledge of R and D activities, whereas on the other hand national R and D programmes have to take account of national goals and expectations. Therefore a close-co-operation between the Scientific Council for Government Policy and the Science Policy Council is a necessity. In order to promote such a co-operation the Government decided that the two Councils will be under one roof in order to facilitate more intensive contacts and they will be also personally linked by having one member in common.

He would like to come back on the discussion on industrial R and D and to make some more comments on the remarks of the Examiners. They have pointed out that the national aerospace laboratory, notwithstanding the outstanding work it is performing, is too large for the industrial needs of the country. However he would like to draw attention to the fact that the aerospace laboratory does much contract work on international level, thus rendering a valuable contribution to international co-operation. Aero-dynamics should also be considered as something like a national specialisation.

The Minister de Brauw added to this point that the Dutch authorities do not intend to make funds available to the Council for specific research activities of its own. They see it as a big stimulant party that will mobilise all sorts of initiatives without being itself responsible for those initiatives.

Professor J. Bennett asked which were the activities of the Ministerial Sub-council for coordination of science policy.

The Minister de Brauw answered that this Sub-Council has just started off and the frequency with which it will meet will be once in two months.

The Delegate for Ireland asked if it is decided to have a small Secretariat for the new Scientific Council for Government Policy.

Professor J. Kremers replied that the Secretariat of the new Council will be quite small, four to five academics at the beginning, and next year perhaps one or two more. The reason for this small structure is the need of a strong relationship with the already existing planning bodies.

Professor B. Rexed expressed the opinion that with a special guiding authority like that of the Scientific Council for Government Policy the Prime Minister may take on higher political importance in the decision-making process in the Government. He asked whether this may lead to a greater integration of decisions inside the Government across departmental barriers.

The Minister de Brauw replied that this was exactly the case. The Prime Minister presides over all Sub-councils of the Council of Ministers. There is a co-ordinating Minister for each area, who proposes the agenda and scrutinises the points that are put on it; no point is put on it without his consent. As to the Scientific Council for Government Policy, the logical way that has been chosen is that it should be responsible to the Prime Minister so that he can see to it that its initiatives can be communicated to those Sub-councils which are concerned. The entry of the Chairman of the Scientific Council for Government Policy into the Cabinet is a very real one: it is foreseen that he will attend cabinet meetings at his wish or at the wish of the Cabinet.

Sir R. Walker remarked that the Scientific Council for Government Policy was a unique initiative. It appears as a body consisting mainly of people with a scientific background and it therefore seems to be an attempt to move in the direction of a closer integration of science with policy formulation. Sir R. Walker though that all the governments of OECD will be very interested as this proposal takes form to be informed on the details of the arrangement. He asked further what sort of reaction has this proposal received so far in the scientific community, the Government establishment and the wider public.

The Minister de Brauw answered that the Dutch authorities will be very glad to inform OECD of the progress they will be making with this Council.

Dr. King concluded then saying that the Netherlands Government should be congratulated on this very important pioneering approach. From the pointof view of OECD countries as a whole, this is very important because so many countries are wondering what to do about government structure, particularly in view of the difficulty of approaching the horizontal inter-connected problems of modern society with the vertical hierarchical structures they have today. A number of countries, e.g. Canada, have been discussing this in detail, but there has not been a lot of experiment made. There is a good deal of reticence in a number of countries about putting this sort of function right in the government machine.

Some governments seem to feel a little afraid that the results from a body like this may inevitably have to be a little radical and therefore perhaps a little embarasssing to administrations and apt to feed political oppositions in some cases. There is sometimes a tendency to create policy think-tanks a little bit outside the government, supported with government money, near enough to have a good symbiosis of some kind but not too near to be really embarassing. In Japan for example they have had a number of attempts by creating think-tanks outside. These think-tanks have proved to be a little bit wild, a little bit irresponsible so that the authorities are not very happy with this experience. Therefore the Dutch will be watched by many countries with a great deal of interest.

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